GIBBSCAM® 14

Version 14 : September 2020

Machine Simulation

CAMBRIO

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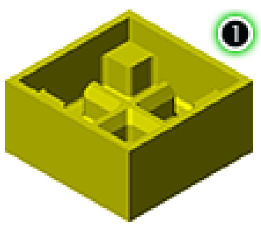
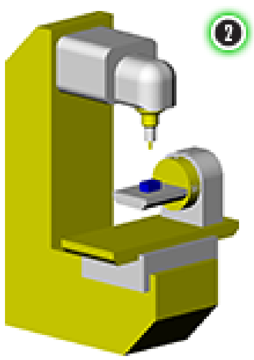
Contents

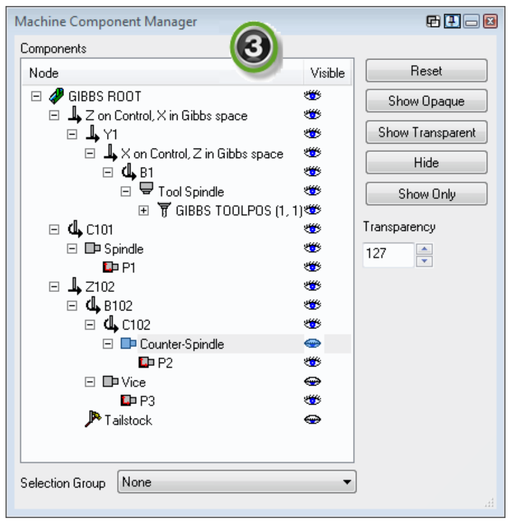
Introduction

The **Machine Simulation** option supplements the standard rendering components of GibbsCAM. It provides a 3D representation of a machine, complete with tool stations and tools, part stations and parts, with many capabilities to hide/show and to emphasize/de-emphasize invidual components and component classes. It also provides special rendering options, including the ability to record and output video.

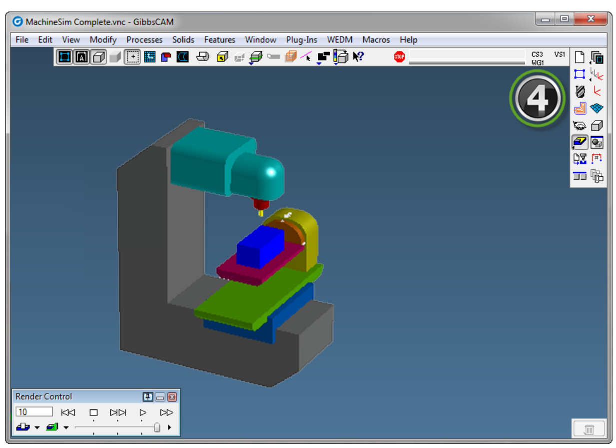
Machine Simulation provides a *machine*-centric view of what is happening, whereas most other forms of rendering are part-centric. Machine Simulation supports lathe, mill, Mill/Turn, Advanced CS, rotary mill, Tombstone Machining System, and Multi-Task Machining parts.







1. A solid model to be cut
2. Solid model of a Machine Tool
3. Machine Component Manager
4. Machine Sim in action



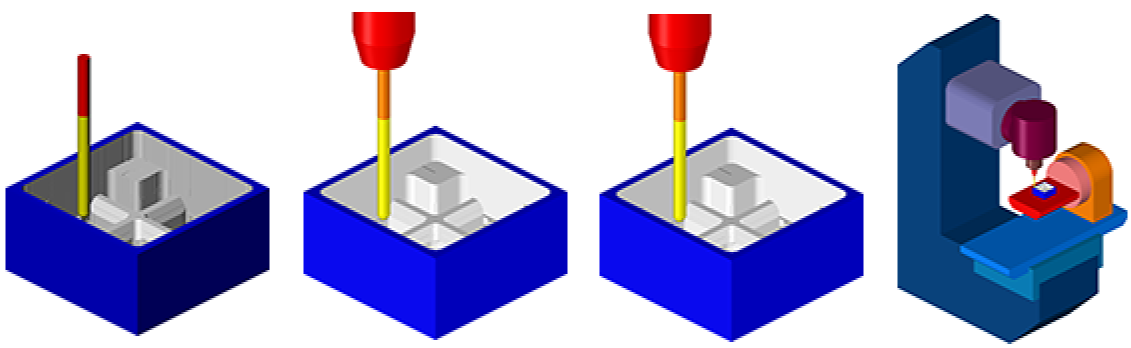
Example of a machine assembly file and a part being rendered with Machine Simulation.

Overview

Machine Simulation is accessed from the Cut Part Render button on the main palette or the Plug-Ins menu. Build Machine opens the interface for defining and creating a machine tool while the Machine Sim option activates the Simulation rendering mode. Typically a machine tool needs to be created before using Simulation but it may be used without a machine tool model in Part Mode. At first glance Part Mode may seem to just be Flash CPR. In fact it is not. Using Simulation in Part Mode will display all inter-operation tool moves that Flash CPR (and the standard rendering) does not display.

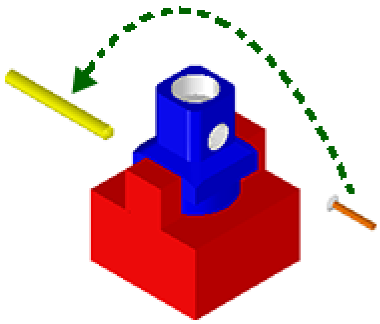
Comparison of rendering modes

Machine Simulation is very different than the traditional GibbsCAM rendering ("Legacy CPR") and is not the same as Op Sim or Tool Sim. Op/Tool Sim are fairly similar to the traditional rendering except for the actual image, in that they use the same part-centric toolpath display as traditional rendering. Machine Simulation rendering in Part Mode (see "Run Mode" on page 43) displays the inter-operation moves that Legacy CPR and Op/Tool Sim do not show. Simulation in Machine Mode can include an actual machine model. ToolSim, which shows the tool movement across a model without rendering material removal, is very useful and is found as an icon option in Op Sim and Machine Sim dialogs.

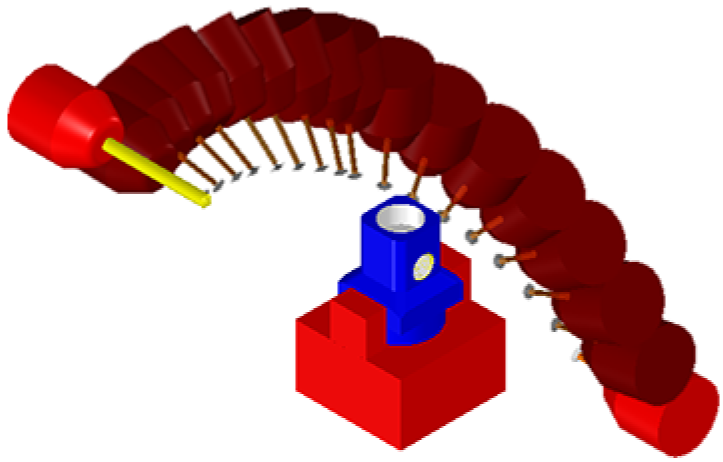


Legacy CPR	Op Sim / Tool Sim	"Part Mode" Machine Sim	"Machine Mode" Machine Sim

While Op/Tool Sim and Machine Simulation may appear similar, their uses are different. A key difference is the Machine Sim capability to display the inter-operation moves of a tool. Op/Tool Sim may be faster than Machine Simulation, as they do not have to render an entire machine model and the moving axes. You may find that when checking your part file you use several or all of the rendering types (Legacy CPR, Op/Tool Sim, and Machine Sim), depending on your needs.

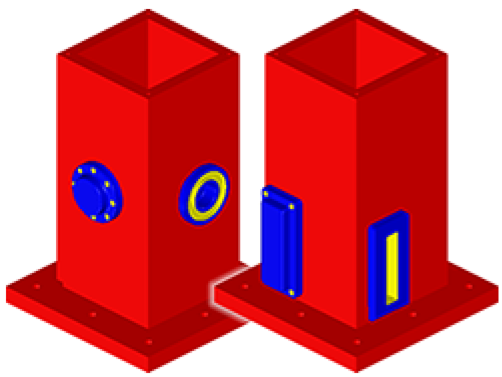


Op/Tool Sim

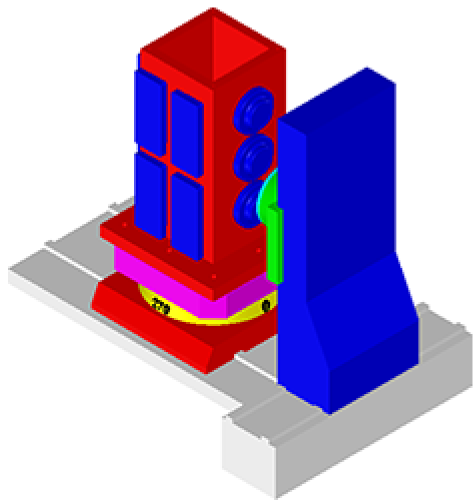


Simulation in “Part Mode”

Machine Sim, in any mode, will show all of the part instances in a TMS multi-part setup, whereas Legacy CPR and Op/Tool Sim only show the single part as programmed in the VNC file.



TMS rendering with Op/Tool Sim



TMS rendering with Machine Sim

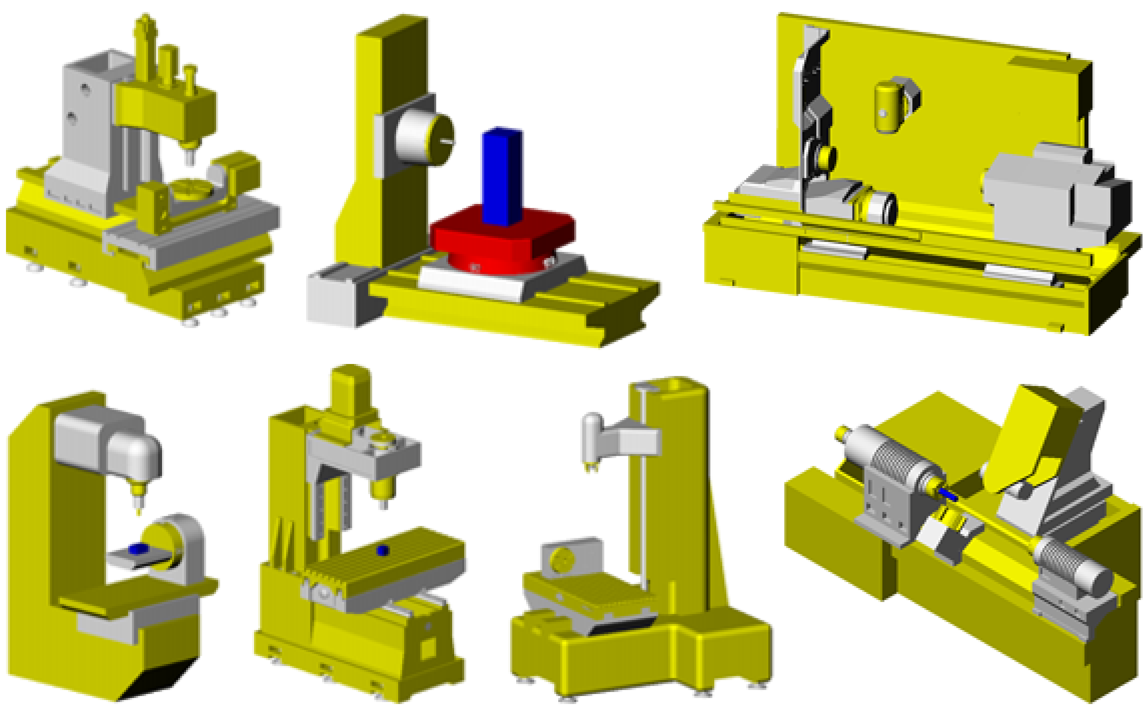
Setup

Overview

Machine Simulation does not really affect part setup, except that each machine assembly requires a custom MDD, which can streamline some of the choices you make when setting up a part including the rotary setup and the post processor selection.

Machine Manager

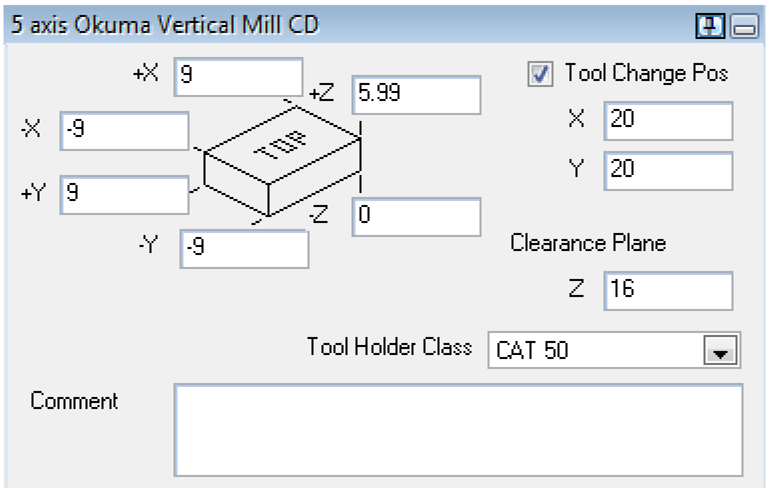
In Machine Manager, you create an assembly file that represents a machine. The representation of the machine can be as simple as just a base, each axis and primary components, such as the table, or it may be very complex, down to modeling the control's buttons and dials. The level of complexity is up to you. When creating the model you should be sure to create a workspace big enough to contain the entire machine.



Examples of machine models. Some are very complex, others are very basic.

Machine Simulation - Clearance Planes

The MDD associated with a machine should reflect the machine's and the post's retract behavior so that Machine Sim shows what will really happen on the machine. For most posts the tool will go home, in some cases the render will only show ZCP1.



Example of a machine whose Tool Change Position and Tool Holder Class are defined in the MDD and are not user-definable. The Master Clearance plane is still definable.

MDDs

Each machine assembly that is created must have a custom MDD (machine definition document) that thoroughly characterizes that particular machine, specifying tool change positions, ranges of motion for axes, and other data. In the case of most simple machines, you can start with an existing, standard MDD and modify the data to fit the machine. Whenever the MDD is selected in the Document Control dialog, the accompanying machine assembly file will be the default machine for Machine Sim. The MDD should be reviewed after you have created the machine assembly file. It is important that the MDD and machine assembly file be consistent in terms of axis definition. This includes number and type of axes, and the position, orientation and order of the axes. See the documentation on Machine Manager for information on creating and modifying MDDs.

In addition to the default machine, the MDD for a Machine Simulation model can set other information. For example, the rotary information for a 4 or 5-axis machine will be pre-determined, meaning that it does not need to be set each time a part is created. The tool change position may be pre-set, depending on your machine and preference. Also, the default post processor is set by Machine Manager.

About the MDDs and Machine Manager

The axes defined in the MDD must be consistent with the axis definitions in the machine assembly. In particular, the number and types of axes must match. If an axis is attached to the machine's table (for machines that are capable of milling operations) or part-holding spindle (for machines that are capable of turning operations) in the machine assembly, then it must be defined in the MDD as being assigned to the part station (i.e. not assigned to the toolgroup). Conversely, if an axis is attached to the machine's tool or toolgroup in the machine assembly, then it must be defined in the MDD as being assigned to the toolgroup (not to the part station).

In previous releases, the term "workpiece" was used instead of "part station".

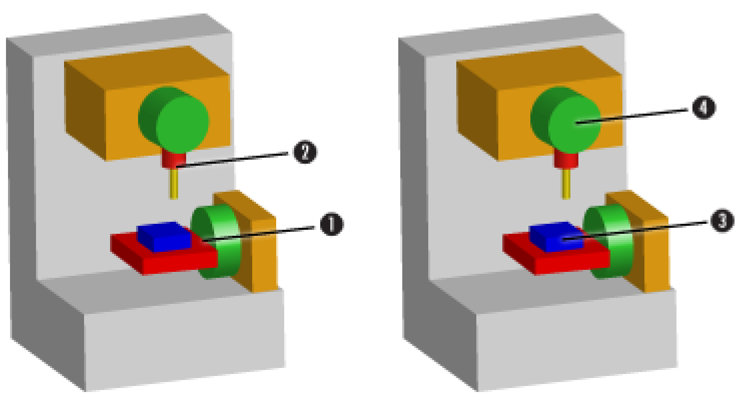
If there are two rotary axes that are connected to each other (i.e. both are on the table, or both are on the tool), then the mounting order in the MDD must match the parent/child relationship defined in the machine assembly. For example, if the A axis is mounted on the B axis in the MDD, then the corresponding A axis must be a child of the B axis in the machine assembly.

Other areas to review for MDD/machine assembly consistency include: pivot distances (i.e. rotary axes locations), axis directions including positive/negative for both linear and rotary axes, and axis names.

The MDD also defines behavior and positions for tool changes and other moves between operations. Many of these moves are not displayed in Cut Part Rendering, but all moves are displayed in Machine Simulation, so it is important that this information be correct in the MDD if any part using a particular MDD is going to be used in Machine Simulation. This includes tool change settings like axis priority, axis retract position type (e.g. full retract, preset position, user defined), and axis retract position. It also includes same tool rotation settings like axis move order and position.

Home Position for Milling-Capable Machines

This class of machines includes 3-axis, 4-axis, and 5-axis milling machines where the part sits on a table. The “Home Position” for toolgroups in Machine Manager is measured from the machine’s origin, which is the axis center of rotation or pivot point that the table is attached to. In the MDD, the Home Position is defined as the distance from the pivot point to the spindle origin. In Build Machine this is the distance between the part origin to the pivot point.



1. Pivot Point
2. Spindle Origin
3. Part Origin
4. Pivot Point

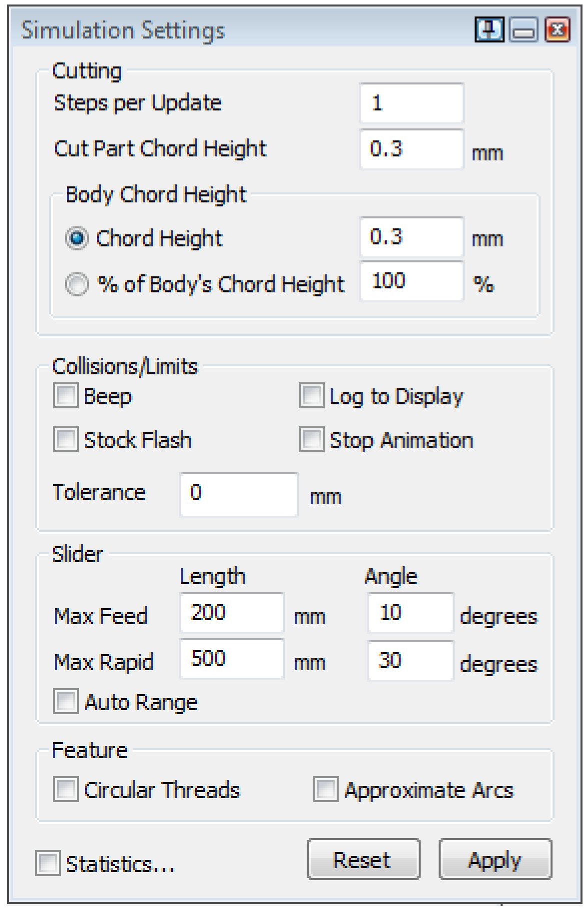
Machine positions required for the MDD Editor

Home Position for Turning-Capable Machines

This class of machines includes anything with a part that can spin. The “Home Position” is the center of the spindle face. All values should be referenced from here.

Machine Sim Settings

Machine Sim Settings are accessible two ways, either from the Machine Sim Render Control palette’s contextual menu or from the File > Preferences menu. When the Machine Sim Render Control palette is open the Edit Flash CPR Settings... button opens the Machine Sim Settings dialog box. The Machine Simulation and Flash CPR preferences are essentially identical but save separate preference data. The Common Reference manual discusses these preferences in detail from a Flash CPR Preferences point-of-view. Be sure to review the various aspects of these controls including Cutting, Collisions/Limits, Slider, Feature and Statistics.



Cutting

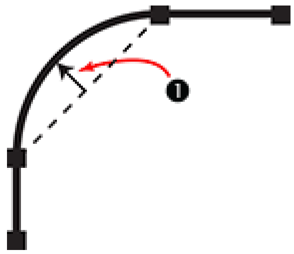
The cutting options section allow you to control the quality and responsiveness of Machine Sim. Please note that the Machine Sim preferences are stored with the part. This means that if you change the preferences but open a part that has an older set of preferences, it will override the changes you have made.

Steps Per Update

Steps per Update specifies the maximum number of CPR features to render before updating the display. Large numbers will increase the rendering speed but will result in a rougher rendering animation. With large numbers the tool may appear to jump ahead of rendering, which will suddenly snap to the tool. This may be jerky, but can be rather fast. A low number provides a smooth animation, but may be slow.

Cut Part Chord Height

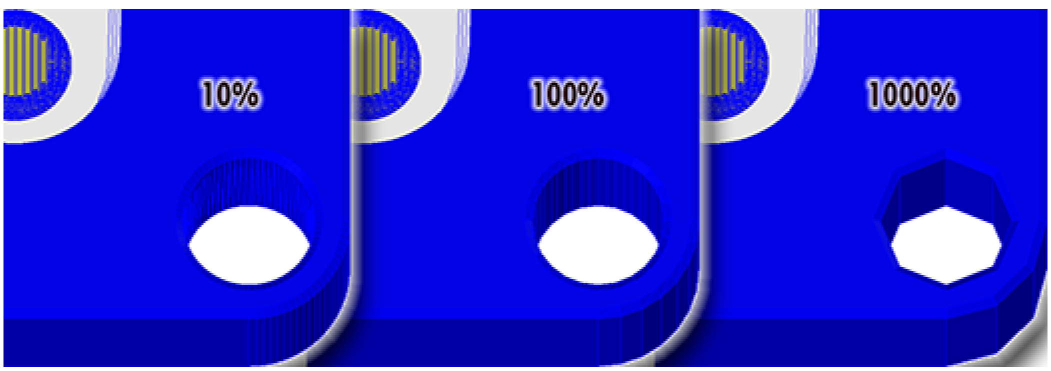
This setting is the resolution for the cut part displayed in Flash CPR. The smaller the value, the higher quality of the display and the more resources needed by the system, resulting in a slower rendering. There are separate settings for inch and metric parts. The separate values can only be set from within a part of that unit type.



1. Chord Height

Body Chord Height

This option determines the resolution of bodies (part, stock and fixtures) in Machine Sim. There are two ways this can be set, either by the Chord Height option (which is setting a specific value), or by the % of Body's Chord Height option. This second option uses the value set from the Properties dialog, (accessed by right-clicking on a body.) A setting of 100% will use the body's Chord Height while a setting of 10% is 1/10th of the body's Chord Height while 1,000% is 10 times the body chord height. Any percentage between 1 and 100,000 is acceptable. As the percentage is set higher the body will appear rougher but the display will be faster and lower percentages mean higher quality but slower response. Note that this setting only affects on-screen display, not the actual machining.



Collisions/Limits

The items found in the Collisions/Limits section of the dialog provide control over how the system reports collision errors while rendering. Any combination of the alert methods may be used to inform the user when a collision occurs.

> Please note that the Collision Checking option (found in the Render Control palette's menu) must be activated for the system to check for collisions.

A collision in Machine Simulation occurs whenever any two objects contact each other during the simulation that are not supposed to touch. Objects in Machine Simulation include machine components and non-machine components. Machine components are objects in the machine assembly that are defined by Build Machine. Non-machine components are not in the machine assembly, but are created by Machine Simulation based on information in the GibbsCAM part file. These objects include tools, holders, fixtures, parts, and stocks. The active cutting tool and its holder always participate in collision detection when collision detection is activated. Other objects participate in collision detection based on their inclusion in collision component groups. Collision component groups are component groups with their collision setting turned on. See "Component Groups" in the Setup dialog for more information.

Non-machine objects are automatically included in component groups based on their logical attachment to an object in a component group. For example, a tool and tool holder are logically attached to a turret by virtue of their assignment to a particular toolgroup and tool position in the tool definition dialog in GibbsCAM. A part/stock is assigned to a spindle or chuck in the machine assembly because of the part body (P-body) that is defined in the machine model. When determining group membership, fixtures inherit goup attributes from the part body associated with the fixture’s spindle.

Machine simulation collisions are detected when collision detection is set on, and any of the following conditions occur:

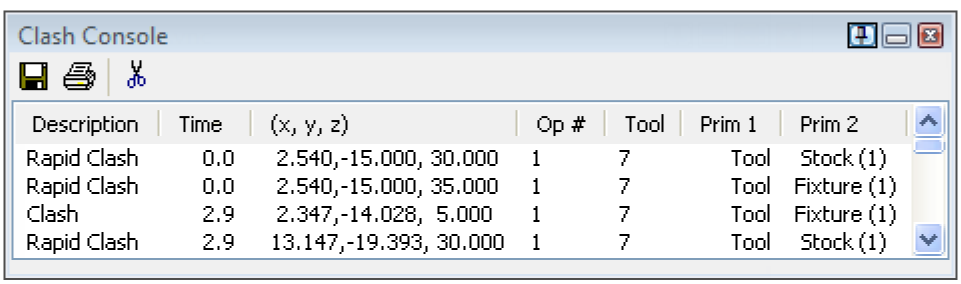
- The cutting portion of a tool contacts the part/stock while in rapid mode.
- The non-cutting portion of a tool or holder contacts the part/stock while cutting.
- Any object that is part of a collision component group contacts any object that is part of a different collision component group.
- Any axis position exceeds the axis limit as defined in the machine assembly for any of the machine components with axis limits (min/max).

Alert Types

You may choose any or all of the various feedback methods that alert you to a collision. The Beep option provides an audible alert, Log To Display will output an error in the Clash Console log window and Stock Flash provides a visual alert to the error by flashing the rendered stock. Stop Animation will cause the rendering to stop when a collision is detected.

Tolerance

The Tolerance setting allows a different value for metric and inch parts. Any collision within the specified tolerance will generate a collision alert.



Description	Time	(x, y, z)	Op #	Tool	Prim 1	Prim 2
Rapid Clash	0.0	2.540,-15.000, 30.000	1	7	Tool	Stock (1)
Rapid Clash	0.0	2.540,-15.000, 35.000	1	7	Tool	Fixture (1)
Clash	2.9	2.347,-14.028, 5.000	1	7	Tool	Fixture (1)
Rapid Clash	2.9	13.147,-19.393, 30.000	1	7	Tool	Stock (1)

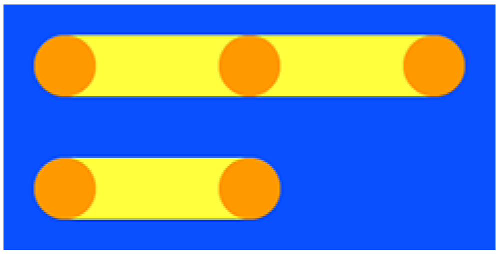
The Clash Console output showing a tool clashing with the stock and a fixture.

Slider

The items in this section affects the responsiveness and quality of the rendering by controlling the maximum step distance between features in rendering. These values are used with the speed slider on the rendering palette. The fastest speed jumps the tool from feature to feature using these settings. Lowering the speed will scale the distances between features. Please note that this does not affect toolpath, only the rendered part. These settings can have a very large impact on the rendering speed versus quality.

Length

The Length value sets the maximum distance between rendered linear moves. Let us imagine a linear cut where the tool will traverse 400mm in a straight line. Using the default settings of 200mm, the display will show this move in two steps when the slider is set to its maximum (fastest) value. If the linear cut was less then 200mm long the rendering shows the cut in one step, at the start and end of the cut.



Angle

The Angle values can have an especially big impact on rotary operations. Like the Length setting, this value controls the rendering steps between features, in this case for angular moves. A low number will create very small angles in rotations, resulting in a smooth image while a high number can create a rendered part that is not smooth but is very fast.

Auto Range

This option will disable the Length values and will instead use the size of the stock (length, width and height separately) to set the maximum feed and rapid lengths. The maximum value for feeds will be set to 1/10th of the largest stock dimension and rapids are double that value. The smallest step that the system will take when rendering is 1/100th of the smallest dimension of the stock.

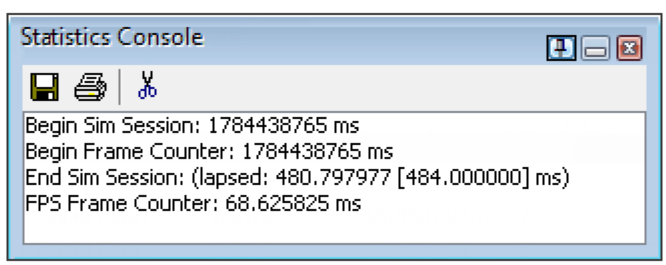
Feature

Circular Threads

This option renders “circular” threads rather than proper spiraled threads. Enabling this option will render threads much more quickly.

Statistics

When the Statistics option is enabled a window opens when you activate Machine Sim. The window logs the current framerate for your machine as well as any logged errors for the CPR session.



Creating a Sample Machine Model

The following material presents a detailed start-to-finish scenario of creating a sample machine model with simulation bodies, using the Test Machine functions to validate the model at various points along the way.

Summary of Steps

Before you begin

Start GibbsCAM 14.
No part is open. The most recent MDD is remembered and loaded in the background.

Step 1: Start Machine Manager and initialize a new MDD

1. Go to Plug-Ins > Machine Manager. (If you see no such menu item, use Plug-In Manager to activate it.)

   Machine Manager opens, showing the most recent MDD.

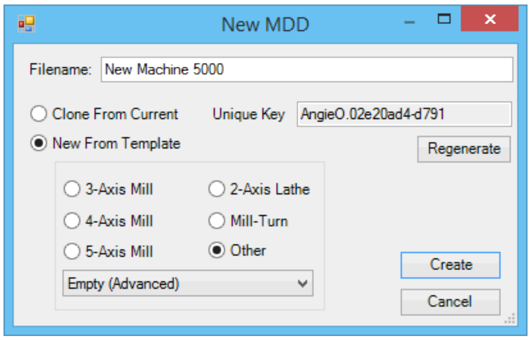
2. Change machine type to 3-Axis Vertical Mill.

   This is the simplest machine to start with.

3. Click New to create a new MDD.

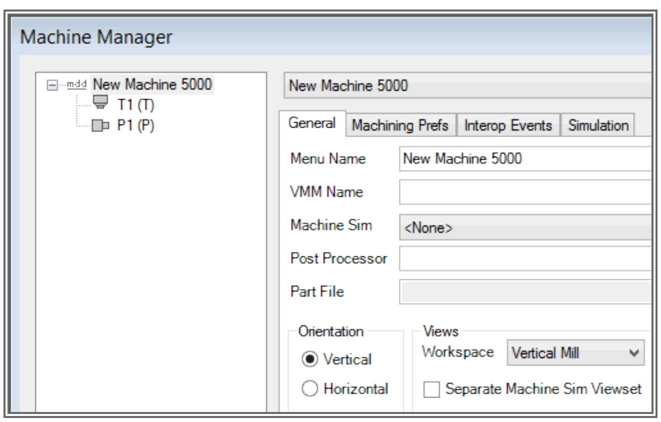
We now have a 3-axis mill MDD that we can customize.

4. Type in Filename: `New Machine 5000`.
5. Choose bullet option New From Template.
6. Choose bullet option Other and from the dropdown select Empty.



7. Click Create and the Machine Manager dialog opens.

   The Kinematic tree contains the minimum it could possibly contain: one Toolgroup (T) and one Part Station (P), nothing else.

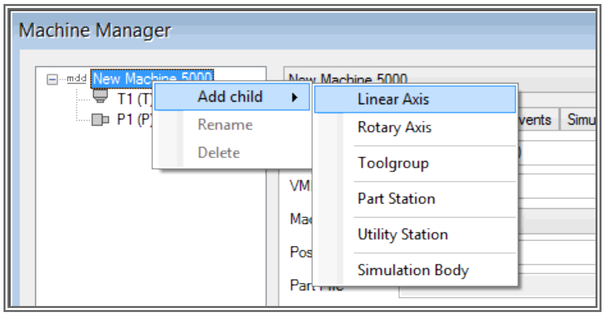


Step 2: Add and configure the three linear axes

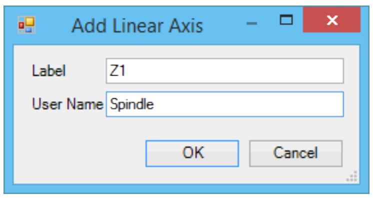
Z Axis

First we will add the Z axis. It is not necessary to add items in any particular order. We will begin with the Z axis because it is on the tool branch and it addresses the part.

1. `Right-click` the Root Node > Add child > Linear Axis.

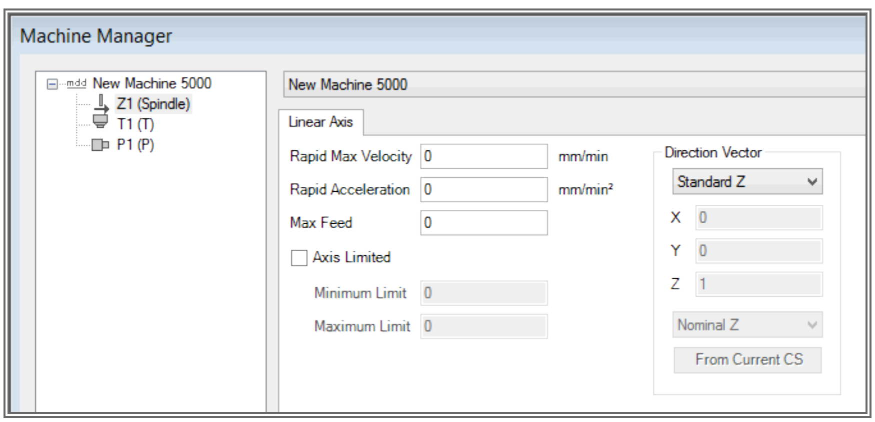


2. Enter details as shown. Label: `Z1`. User Name: `Spindle`. (The convention for Tool axes is to start with 1 and go up.)



Please Note: The User name of an axis entered here, will appear throughout Machine Manager (including Test Machine and MTG) and also in Render Tracking.

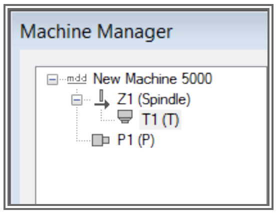
3. Click OK and see the result:



- Tree has Z1 directly below root (sibling with T1 and P1) and is selected.
- The Linear Axis tab opens and shows what options you have for a linear axis.

Now we will configure the Z axis.

4. In the Direction Vector area, a pulldown menu provides options for X,Y,Z, Standard and Reversed vectors, plus a Custom option. Retain the default (Standard Z).
5. In the tree, `click and drag` T1 onto Z1.



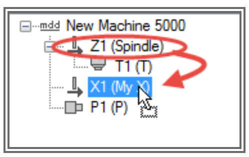
X Axis

Next, we will add the X axis.

Right-click Root > Add child > Linear Axis. Lable it X1, user Name: My X.

We will now configure the X axis:

6. In the Direction Vector area, again retain the default (Standard X) from the pulldown menu.
7. In the tree, drag Z1 onto X1.



Notice how the subtree (T1) comes along.

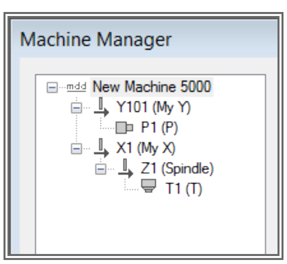
Y Axis

Finally we will add the Y axis.

8. Right-click Root Add child> Linear Axis. Label: Y101, (The convention for Part axes is to start with 101 and go up.) user Name is My Y.

We will now configure the Y axis.

9. In the Direction Vector area, pulldown menu, retain the default (Standard Y).
10. In the tree, drag P1 onto Y101.



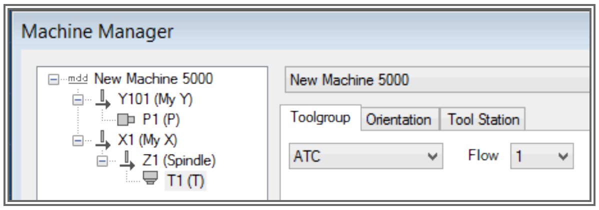
11. Save the MDD.

We have created a very basic 3-axis machine but it needs much more detail. The next item we will configure for this example machine, is an ATC toolgroup.

Step 3: Configure the toolgroup

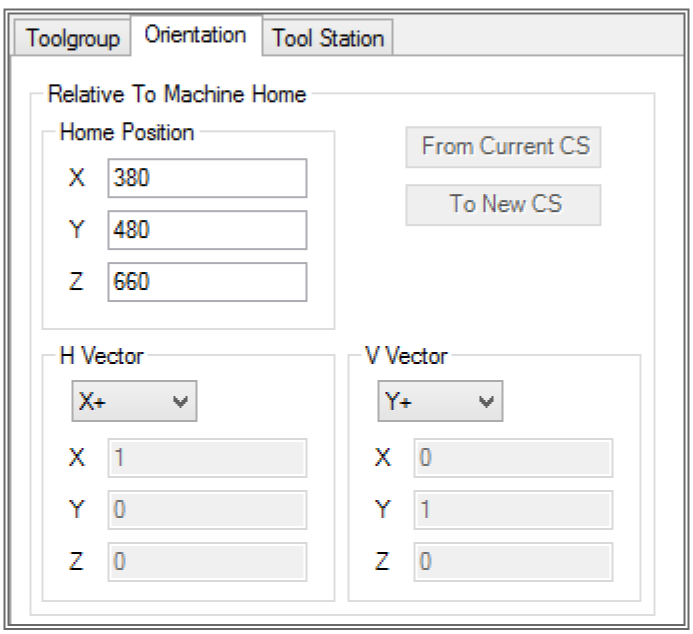
1. In the Kinematic tree, click T1.

   The dialog presents three toolgroup-specific tabs.



2. Select the second tab (**Orientation**) and enter the following: (double check that the dimension is set to mm.)

   Retain the H Vector and V Vector defaults.

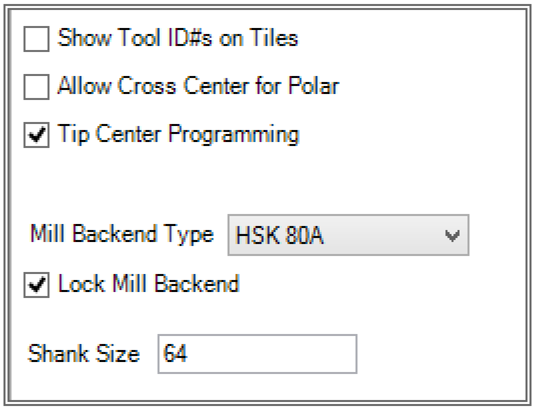


   Select the first tab (`Toolgroup`) and:

3. In the pulldown menu, change the type to `ATC` (Automatic Tool Changing head).

   Notice that many other controls on the tab just go away, as they are not needed.

4. Change the other options as shown below:



We checked the box for Lock Mill Backend since only one backend will ever be encountered (as is the usual case). The value entered into the Shank Size box represents a maximum shank size. ie. in this case no greater than 64mm.

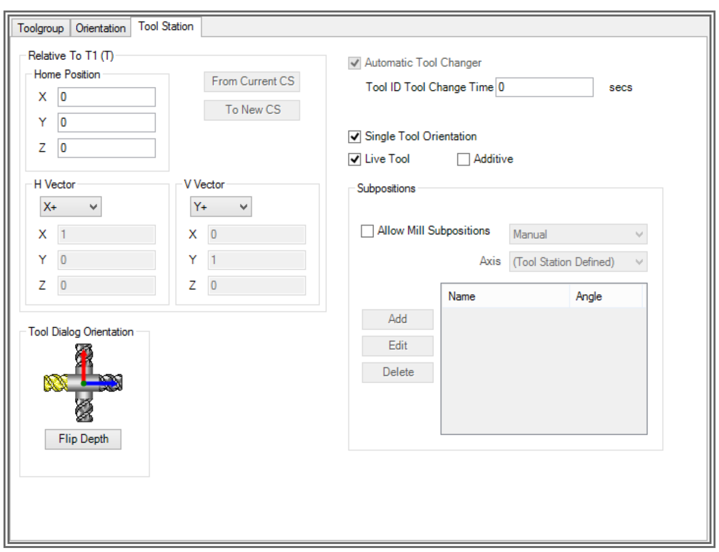
5. Select the Tool Station tab and enter the following:

- Retain values for "Home Position".
- Select the checkbox for Single Tool Orientation.

This means that when users see the tool dialog, they will not have to choose from the stations on the tool cross.

- Retain the selected status for the Live Tool checkbox.
- Retain default choices for vectors.

Note: If your machine had right-angle heads, these would have to be configured. In this case it is not necessary.



6. Save the MDD.

We still have the rotary axes to add, but before that we will create some Simulation bodies so that we can start using Test Machine.

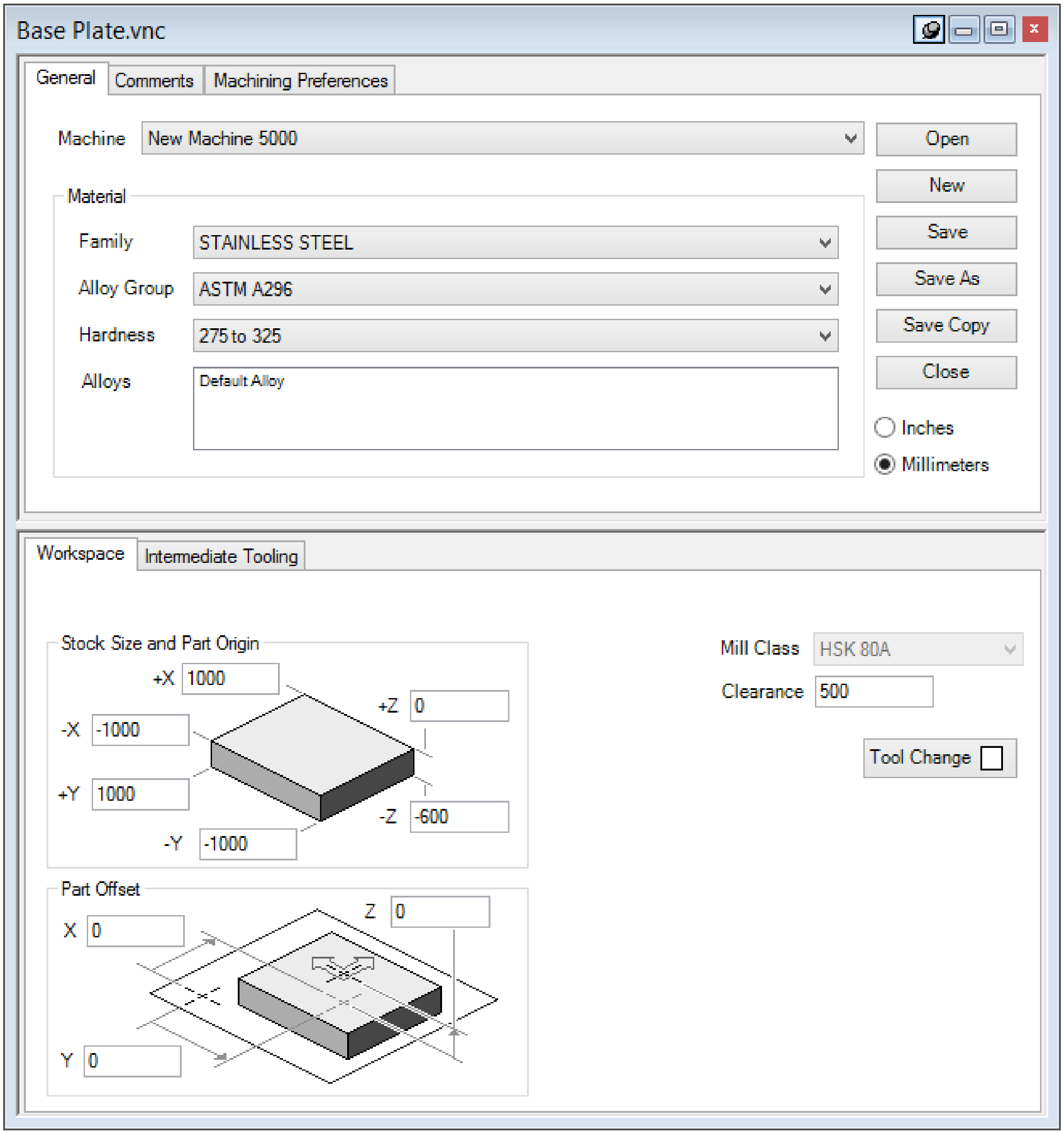
First we will add a base plate and color it black, and then add a cylinder to represent the spindle, which will be red.

Move the Machine Manager dialog to the top of the workspace and `Click` the roll-up icon  on the title bar to hide the dialog.

Step 4 Add the first two simulation bodies and test the machine

First we will make a black Base Plate which will be used only for simulation purposes.

1. File > New. Call the file `Base Plate` and save it in your preferred tutorial directory.
2. In the DCD enter the following mm values:

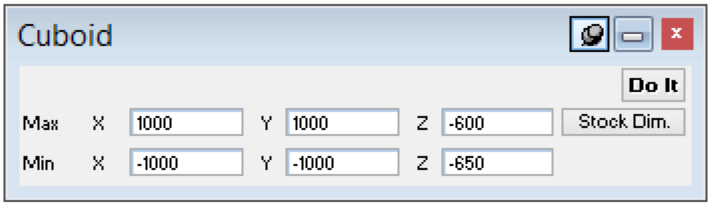


3. Close the DCD dialog.

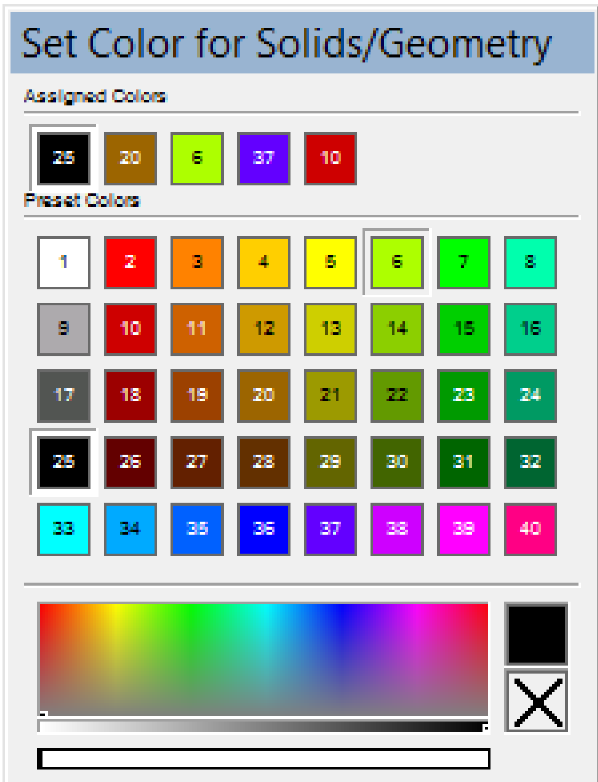
   In the part file, make sure you are in isometric view. We will now create a large cuboid.

4. Open the Create Solid dialog and choose Cuboid. (Solid Modeling > Create Solid > Cuboid).

5. In the Cuboid dialog, click the "Stock Dim" button. This will supply most of the dimensions you need. Now change Max Z = `-600` and Min Z = `-650`.



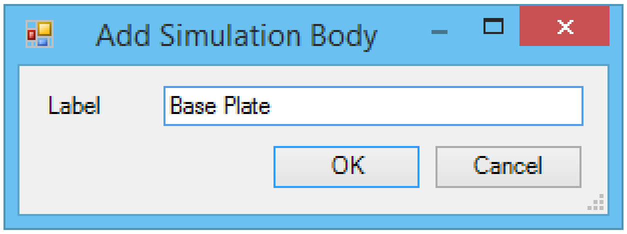
6. Click Do It.
7. Right-click on the unselected body and choose > User Color from the menu.
8. Change the color of #0 (Body) to Color #25 (black), then close the attribute dialog.



9. Open the CS list dialog. You will be watching it in the next step.
10. Save the part file.

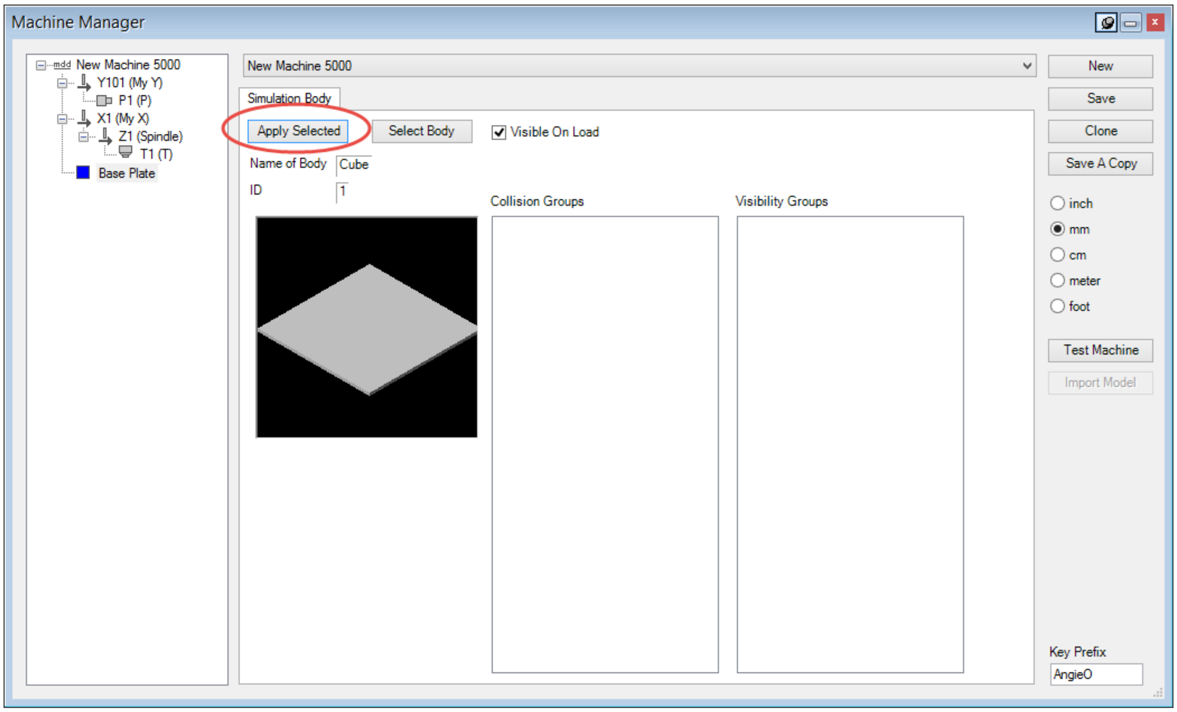
We will now add the base plate body as a Sim body in Machine Manager.

11. Unroll Machine Manager by hovering over the visible title bar.
12. Right-click the Root and choose Add child > Simulation Body.
13. Label the shape `Base Plate` and click OK.

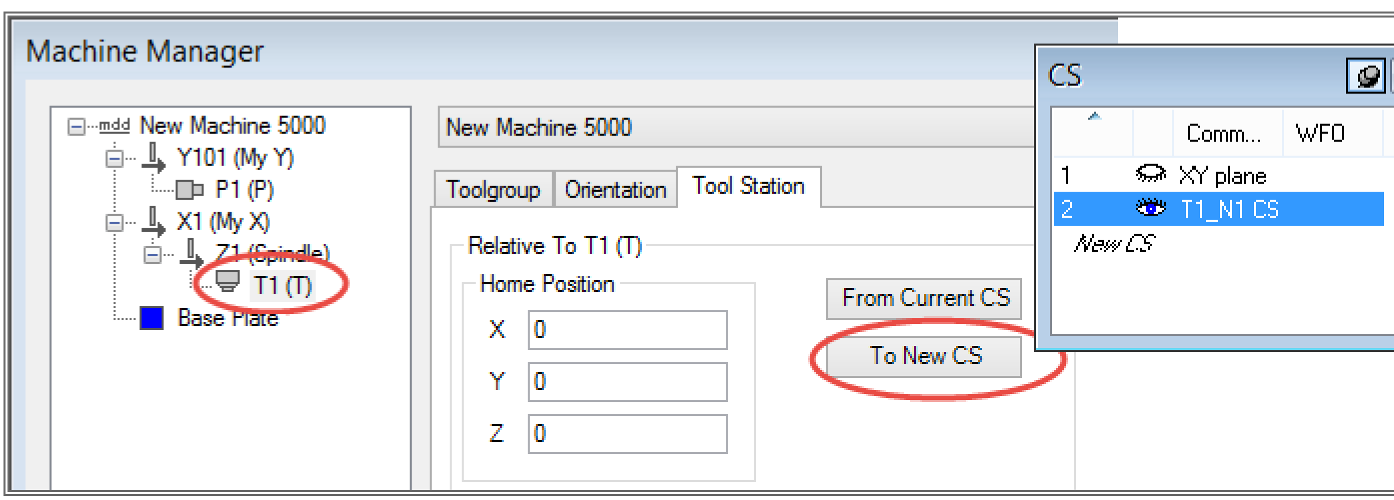


The Simulation Body tab opens, prompting you to configure the body.

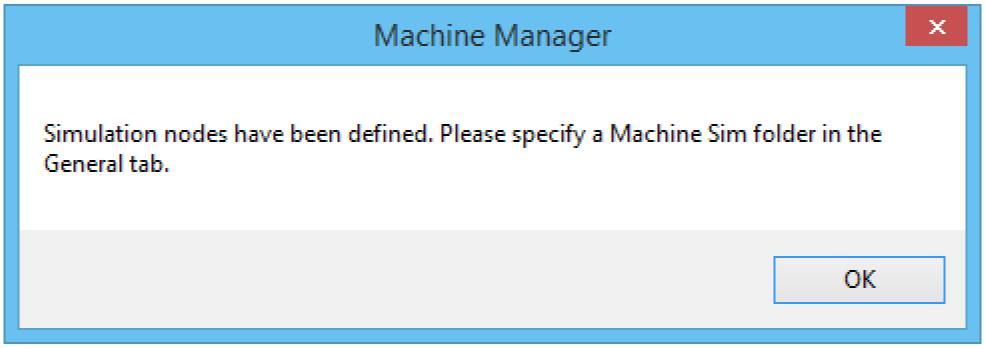
14. Ensure the body in the workspace is selected, then click Apply Selected. The image appears in the first column.



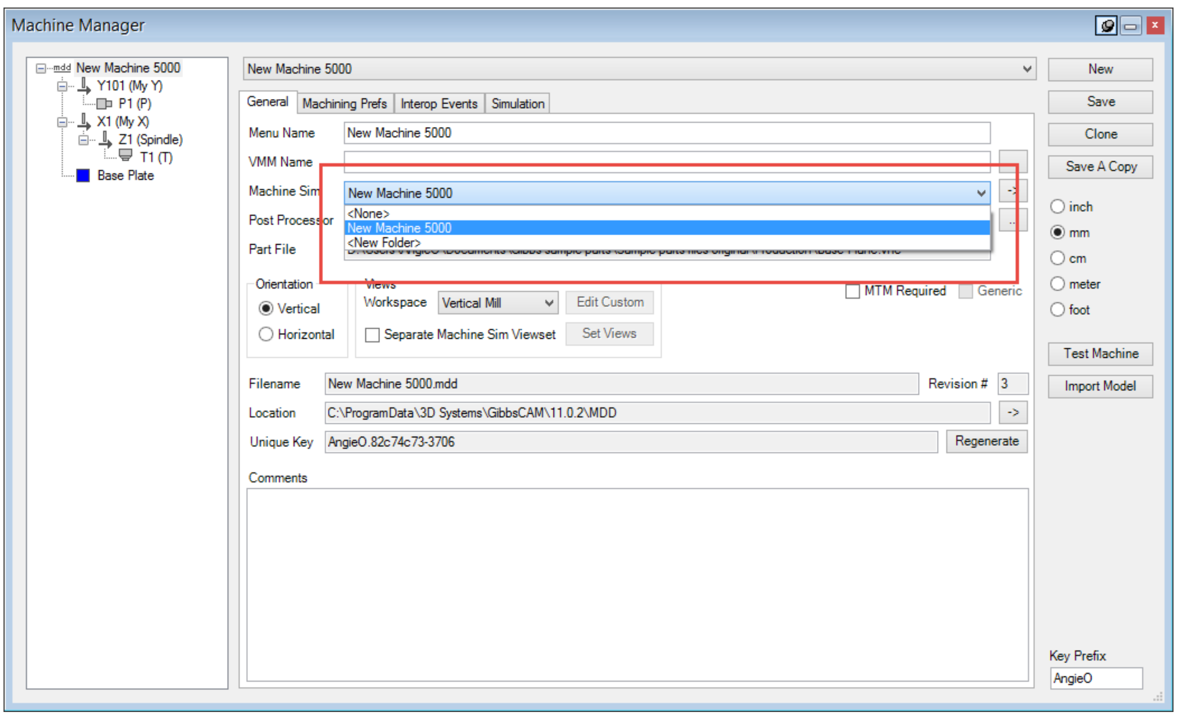
15. Click toolgroup node T1, and in the Tool Station tab click To New CS. Notice a new CS named T1_N1 CS is created.



16. Click Save in the Machine Manager dialog. You may be presented with an error message:



17. Click OK and use the dropdown menu in Machine Manager to choose the Machine Sim subfolder `...\`*<version>*`\MachineSim\NewMachine5000`. All Simulation parts will now be saved to this location.

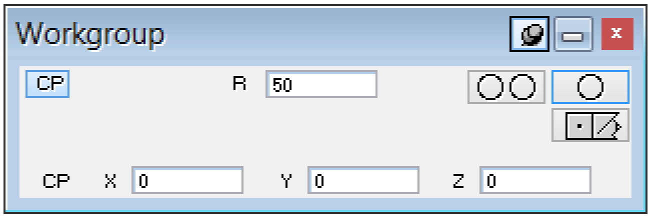


18. Roll up Machine Manager by moving your cursor out of the dialog.

We will now make a second Sim body in the Base Plate file, a basic spindle:

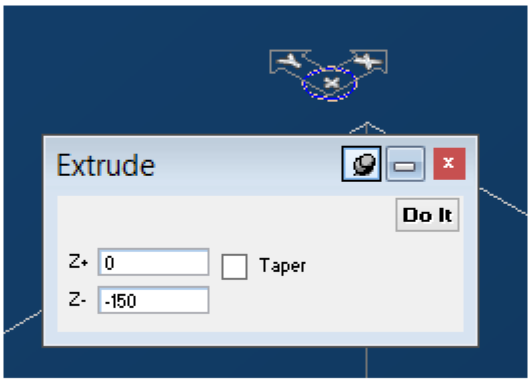
19. Change CS to the newly created, T1_N1 CS.

20. Create a circle as shown below Geometry > Circle > (center and radius).



This circle will be used to create an extruded body to represent the spindle.

21. (Create Solid >) Extrude:
22. Select the circle. Enter the following values and click Do it.



23. Right-click the unselected body and choose User Color. Set the color of #0 (Body) to Color #10 (red).
24. Select the new solid body.
25. Save the part file.

Now we will add the cylinder as a Sim body in Machine Manager.

26. Hover over the rolled up Machine Manager to open it.
27. Right-click Z1 Add child > Simulation Body. Call it `Tool Spindle` and ensure Apply Selected is checked, then click OK.
28. Verify that the image is as you expected.
29. Save the MDD.

We are now able to use the Test Machine function for a very basic test.

1. Click Test Machine. (If prompted to do so, save the current MDD.) Move the curser out of the Machine manager dialog to re-pin it. The Test Machine dialog and Machine Sim Rendering palette will be visible.

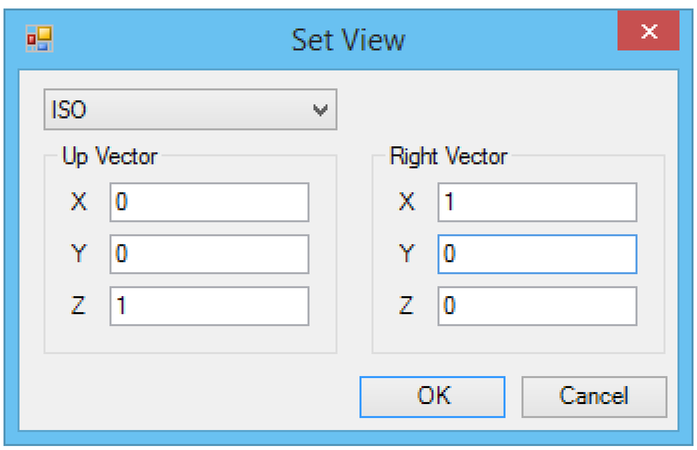
- On the Test Machine dialog, slide the X1 slider and the Z1 slider and see how the "spindle" moves and the base plate does not.
- Slide the Y101 slider and see how nothing moves.
- Close the Test Machine dialog.

You may have noticed that the machine's ISO view is different from GibbsCAMs .

We will be fixing this in the next step.

Step 5 Set the machine's ISO view to reversed

1. In Machine Manager, click the Root node (and then, if necessary, the General tab).
2. Click the Workspace pull-down in the Views section and select Custom.
3. Click the Edit Custom button, enter the following, then click OK.

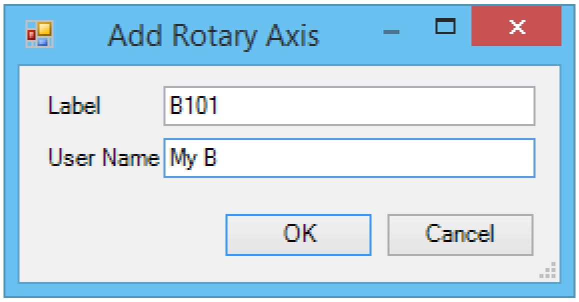


4. Save the MDD.
5. Click Test Machine and press CTRL+I to change to the new machine-ISO view.
6. Slide the X1 slider and note the corrected behaviour. Close the Test Machine dialog.

Step 6 Add another axis and Sim body, and test the machine

Now we will add the first rotary axis.

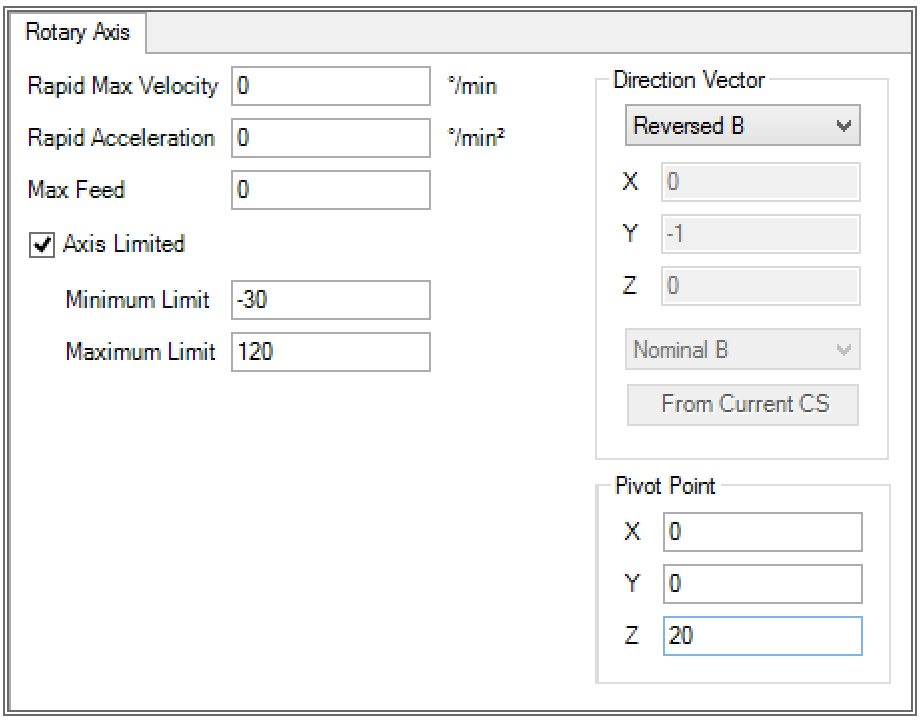
1. In Machine Manager, right-click Y101 and Add child > Rotary Axis. Enter details as follows then click OK.



2. In the Rotary Axis tab, change the Direction Vector to Reversed B.

   (Remember that this machine's ISO is reversed.)

3. Select the "Axis Limited" checkbox and set the values as shown.

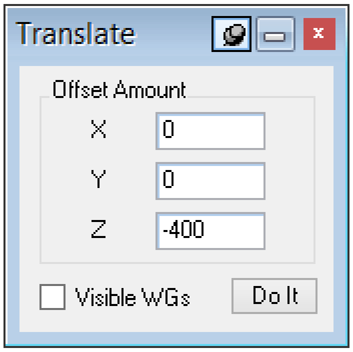


4. Save the MDD and roll up Machine Manager.

We will now create the third Sim body, the brown Table in the part file.

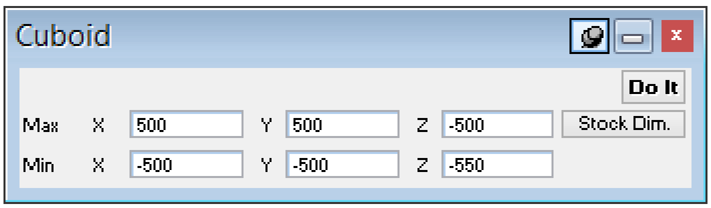
5. Select CS: XY plane.

6. Select the base plate, and move it down out of the way: using Modify > Translate as shown below. Do it.



Now we will create a cuboid to represent the table:

7. (Create Solid >) Cuboid as shown. Do It.



8. Right-click (unselected body) you just created> User Color and change the #0 (Body) to Color #20 (brown).
9. Save the part file.

Return to Machine Manager and add the new brown cuboid as a Sim body.

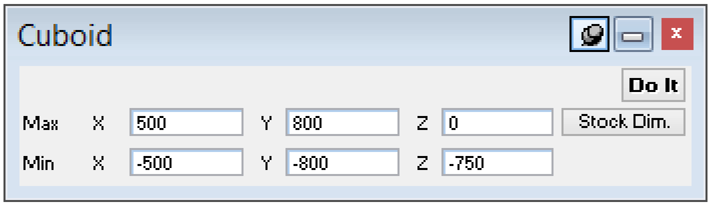
10. Select the brown body, and then unroll Machine Manager.
11. Right-click B101: Add child > Simulation Body. Call it `Table` and ensure Apply Selected is checked, then click OK.
12. Verify that the image is as you expected.
13. Save the MDD.

Click Test Machine again and notice the new B101 slider. Experiment with the B rotations and Y slides, and then close Test Machine.

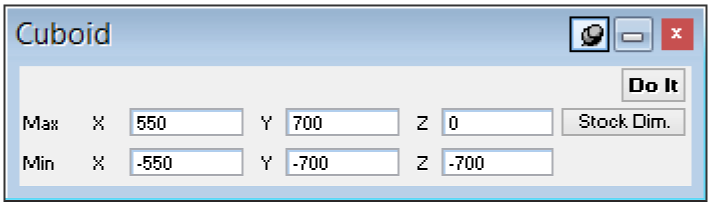
Step 7 Add remaining axis and sim body, and test the machine

In the part file we will create two cuboids whose intersection will represent the fourth Sim body, a trunion:

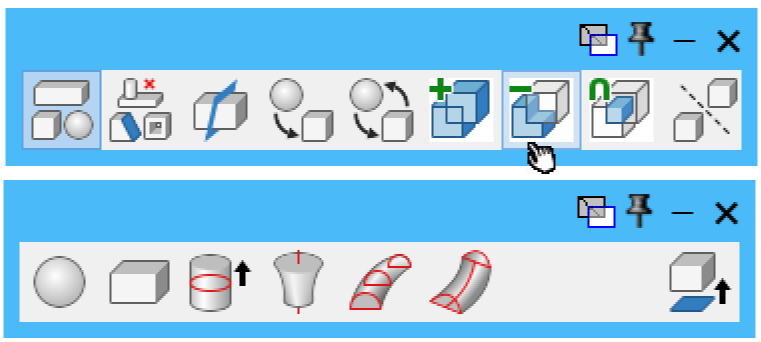
1. In the CS: XY plane, Create Solid > Cuboid as shown: Do it.



2. Now create a second cuboid as shown below: Do it.



3. Select big cube, then ctrl-select the smaller, (in that order) and Subtract.



4. Right-click the unselected body you just created and change the color to Color #6 (green).
5. Save the part file.

In Machine Manager, we will add the green trunion as a Sim body:

6. Select the green body, and then unroll Machine Manager.
7. Right-click Y101: Add child > Simulation Body. Call it `Trunion` and ensure Apply Selected is checked, then click OK.OK.
8. Verify that the image is as you expected.
9. Save the MDD.

And next we will add the second rotary axis:

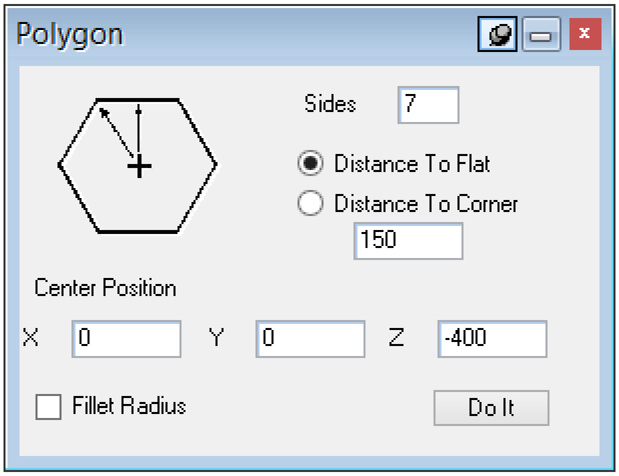
10. In Machine Manager, right-click B101 and Add child > Rotary Axis. Label it `C101`, user name `My C`, then click OK.

    Make sure the Direction Vector is set to Standard C.. The Pivot point can remain as `0,0,0`.

11. Drag P1 under C101.

In the part file, we will create the fifth and final Sim body, a purple heptagon:

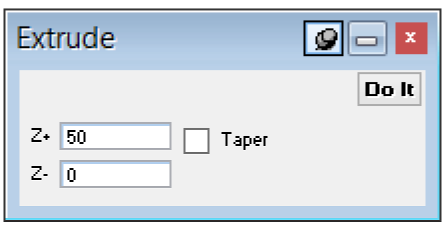
12. Geometry > Shape > Polygon:



Use this heptagon to create an extruded body representing the rotary table:

13. (Create Solid >) Extrude:

14. Double-click the heptagon.



15. Right-click the body and change the color to Color #37 (violet).

16. Save the part file.

In Machine Manager, we will add the violet rotary table as a Sim body:

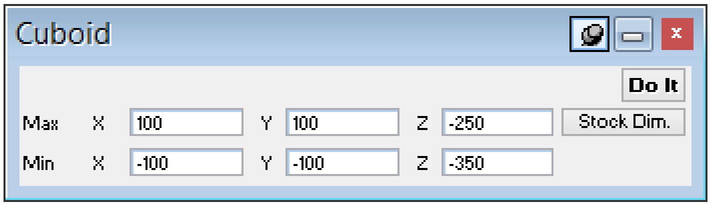
17. Select the violet rotary table and then unroll Machine Manager.

18. Right-click C101: Add child > Simulation Body and call it `Rotary Table`.

19. Verify that the image is as expected.

20. Save the MDD.

In the part file, make a stock body, a cube:

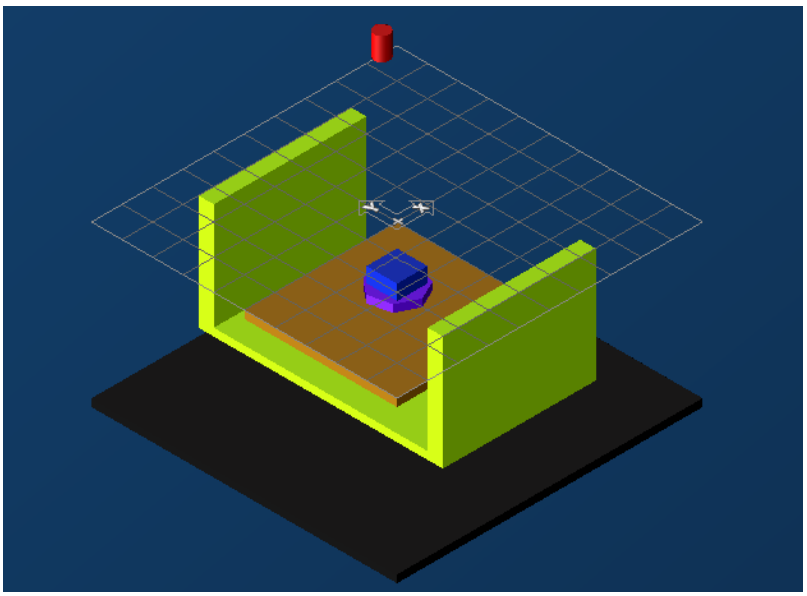


21. Right-click the new cuboid and designate it as stock > Body type > Stock.

22. Save the part file.

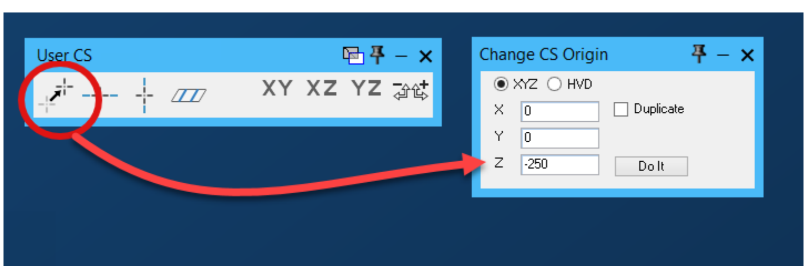
Step 8 Create operations

Now we will create a simple machining process that consists of pecking four holes in the stock, to demonstrate that the machine we just created works correctly.

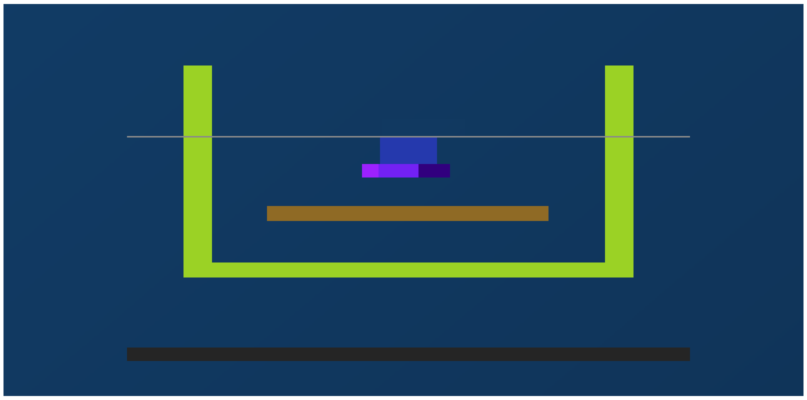


1. Create a new CS off the XY plane, to hold the geometry for the operation.

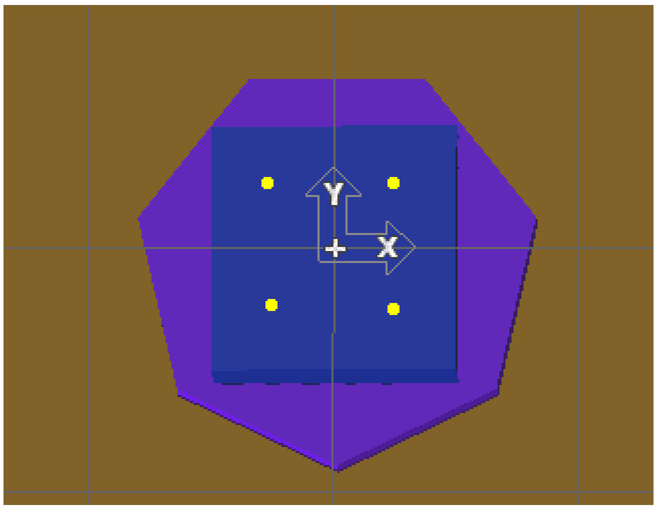
2. Move the origin to Z -250:



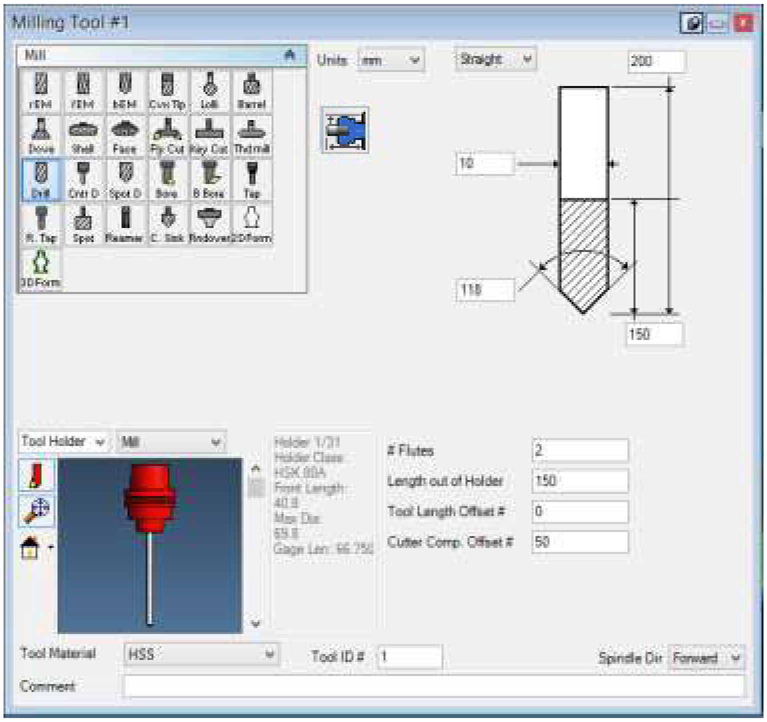
The CS is now on the stock surface.



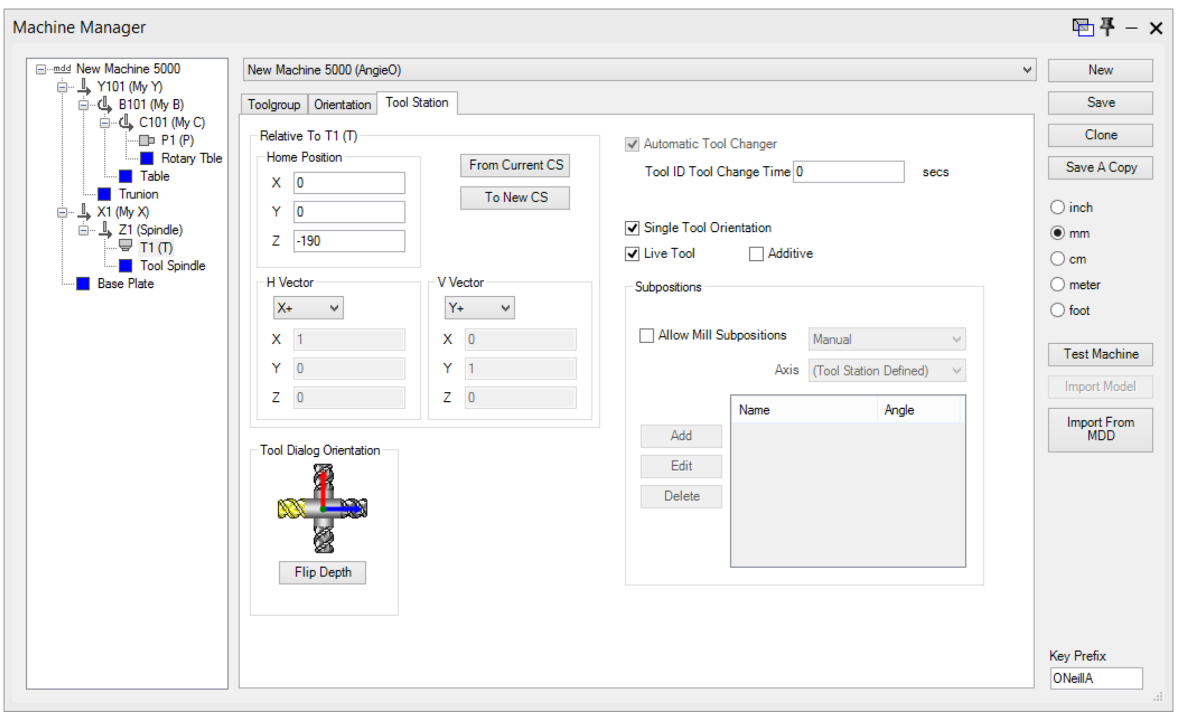
3. With the new CS selected, create four points.

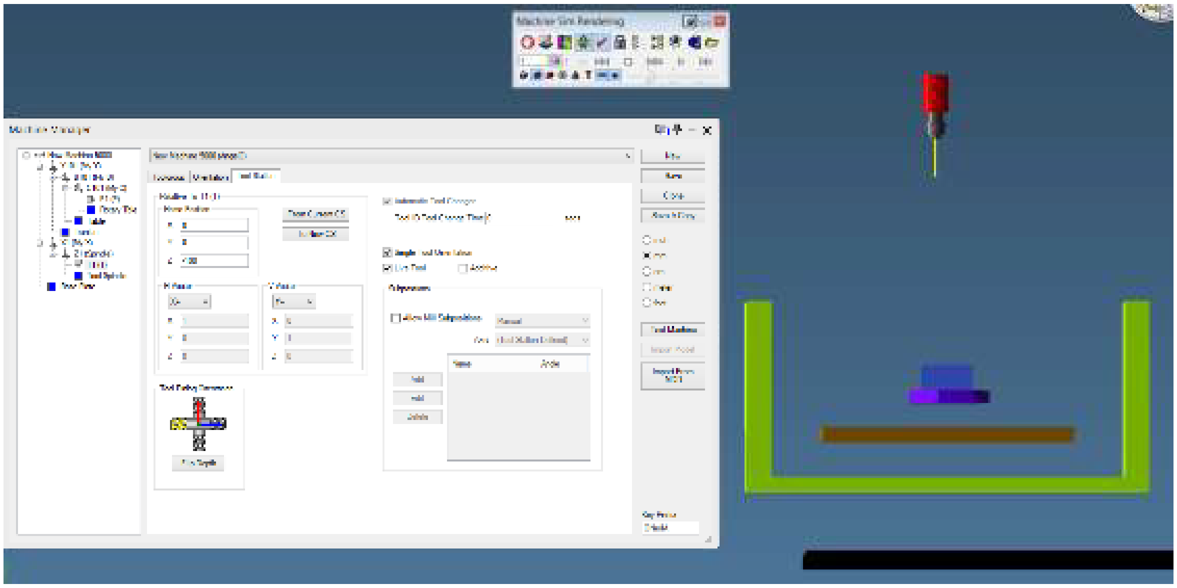


4. Create the tool, using values as shown:



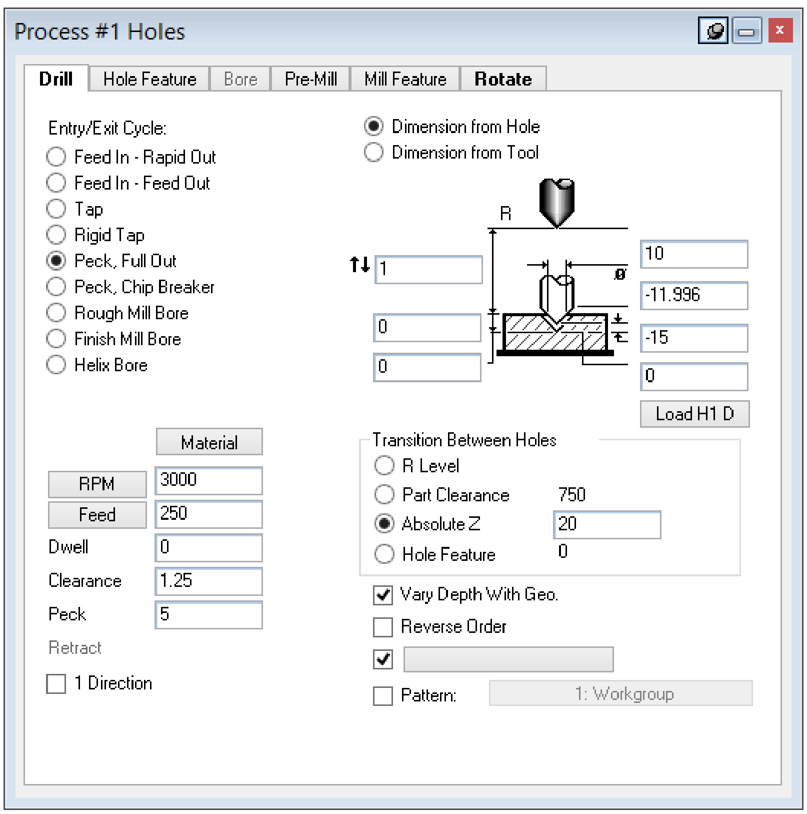
5. Now, set the Home position of the tool. In Machine Manager, **Tool Station** tab, set the Home Position to `Z -190`. This should place the tool and tool holder right below the spindle.



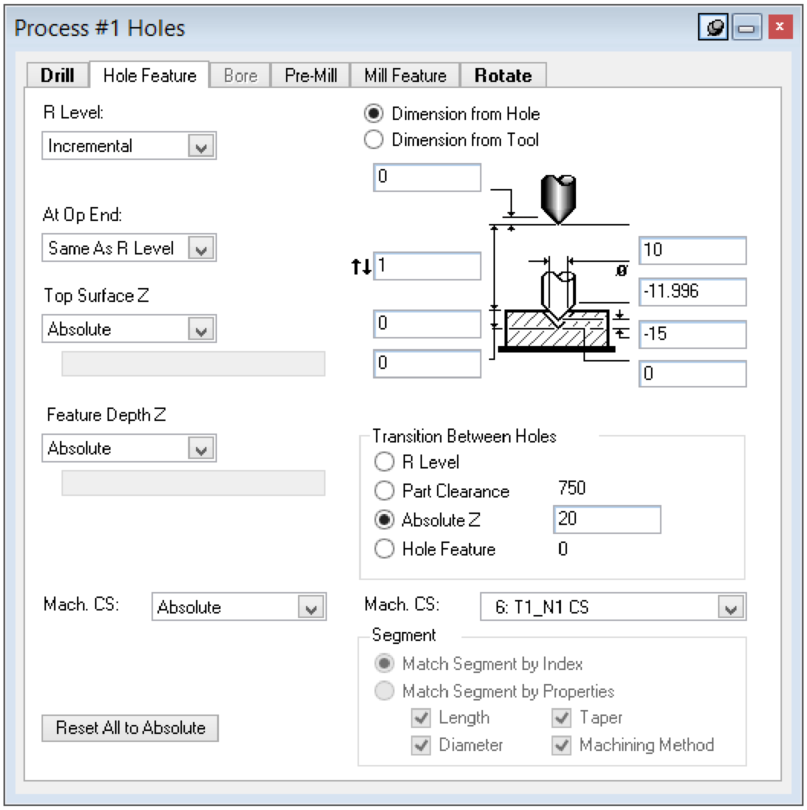


Next, we will set up a Holes process using the **Drill** tab, the **Hole Feature** tab, and the **Rotate** tab.

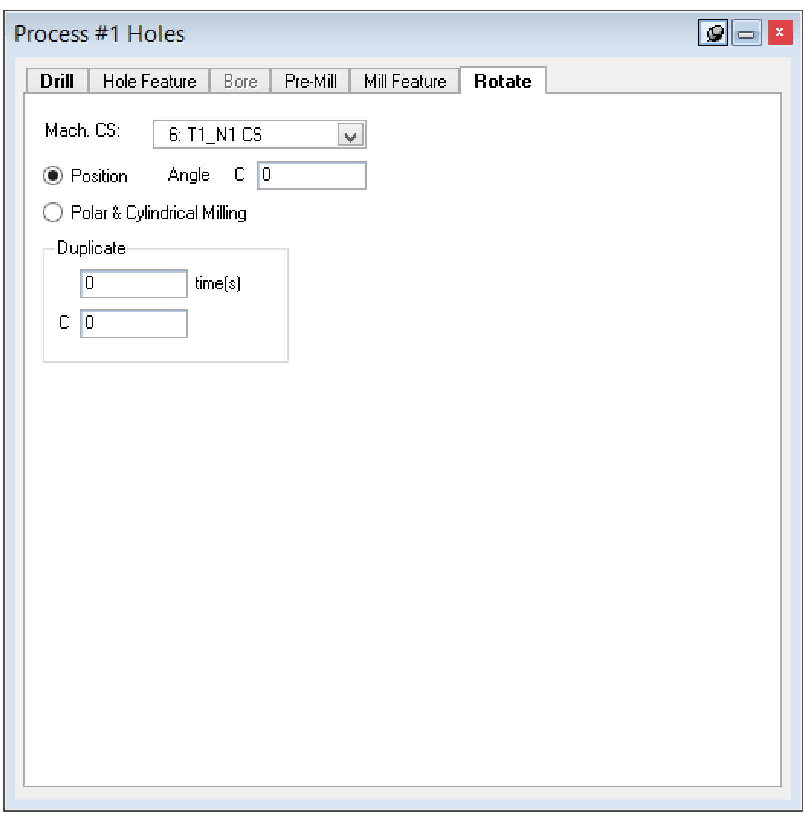
6. Specify settings and values in the **Drill** tab as follows:



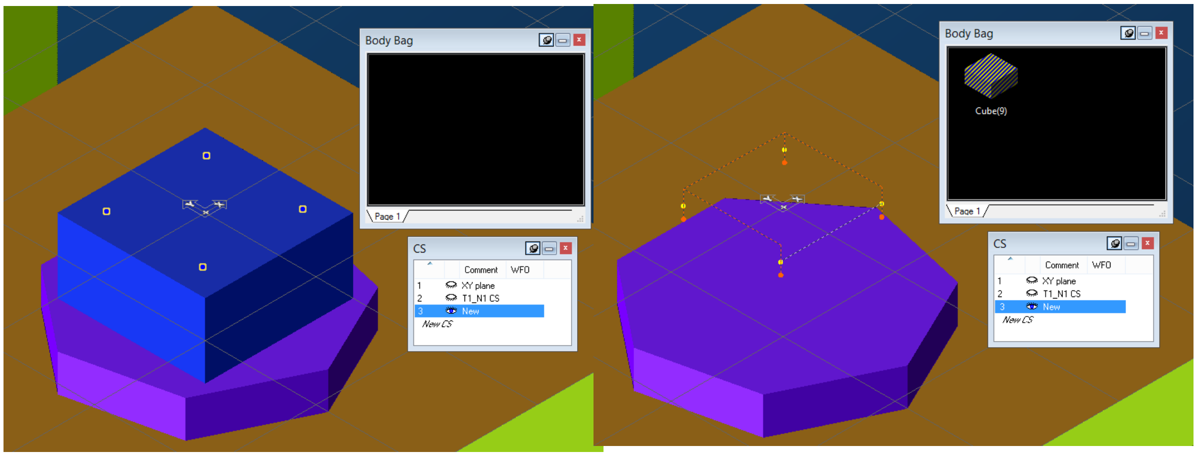
7. Specify settings and values in the **Hole Feature** tab as follows:



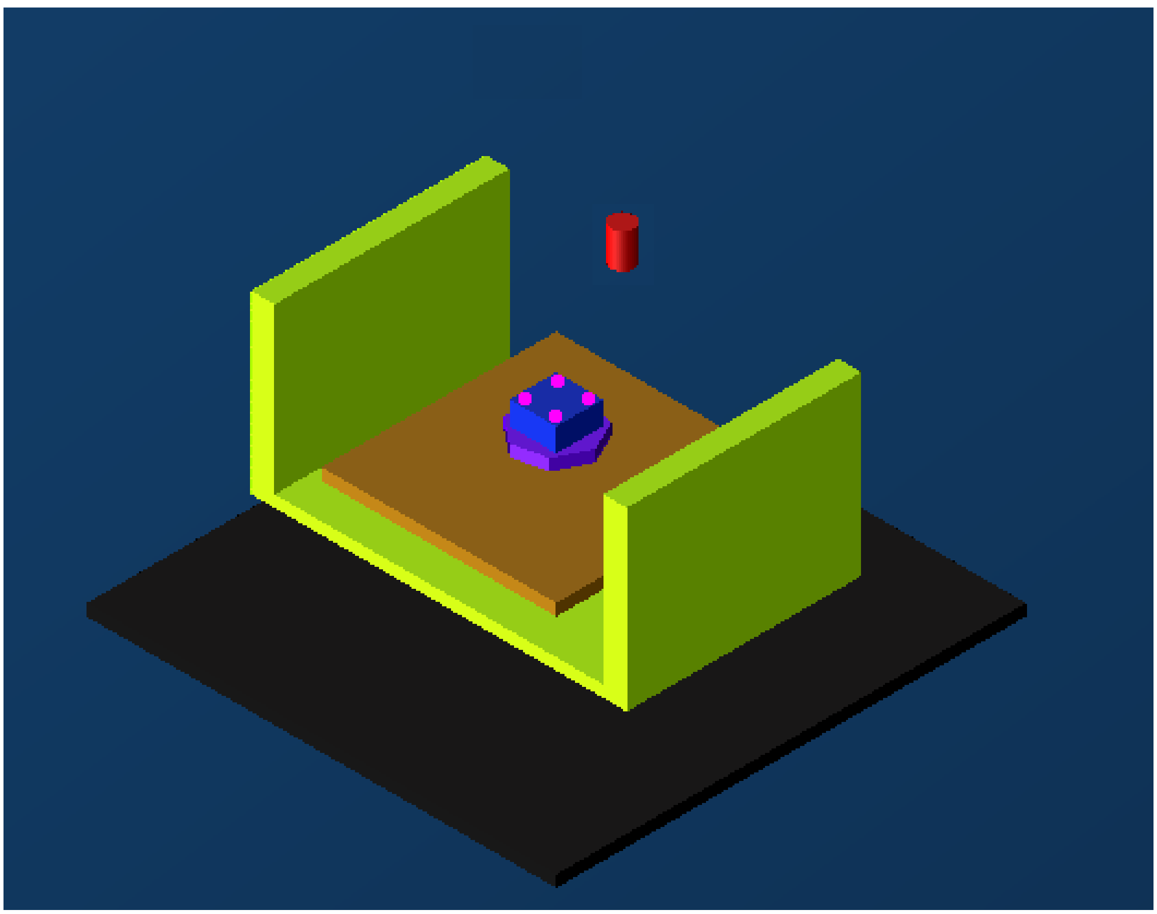
8. Specify settings and values in the **Rotate** tab as follows:



9. In the workspace, select all four of the points on the stock and click Do it. In the screenshot on the right, the stock has been placed in the body bag to show the toolpath.



10. Now render your operations with your new machine.



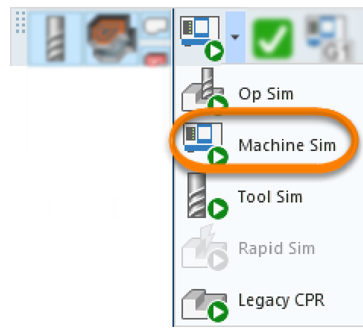
To use this machine for rendering operations, load your own Mill part file, select Machine Sim Rendering, then click the load machine icon on the Machine Sim palette. Now choose New Machine 5000 from the list and click Load Machine.

Using Machine Simulation

The Basic Steps

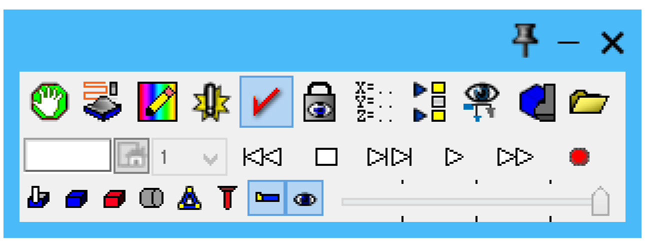
This section of the manual details the use of Machine Simulation. There are five basic steps: Step 1: Activate Simulation ; Step 2: Select a machine model, Step 3: If Necessary, Update Part Offset in DCD; Step 4: Select Rendering Options and Step 5: Run the Simulation.

Step 1: Activate Simulation



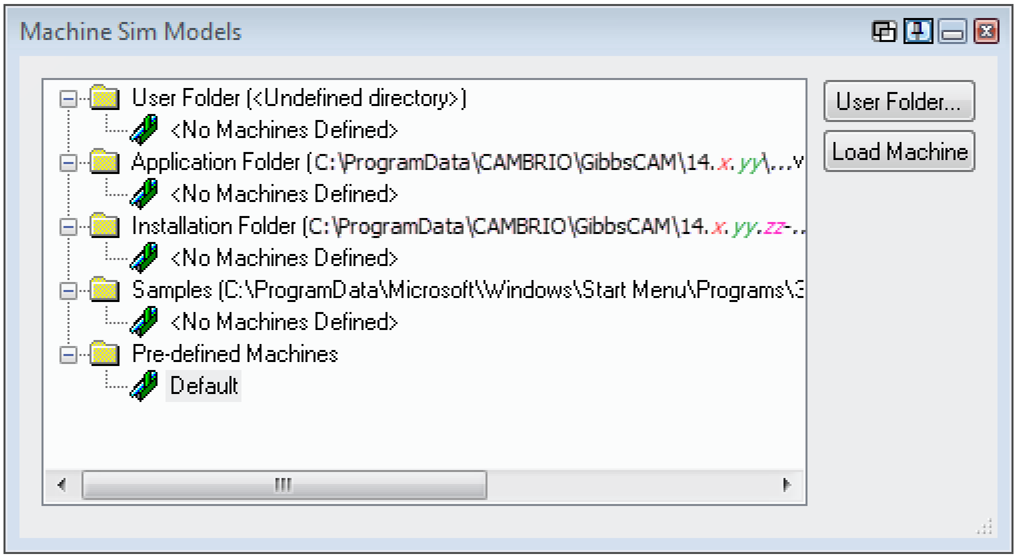
To set the rendering mode to Machine Simulation: On the top-level menu, Sim icon, click the down arrow and, on the pulldown menu, choose Machine Sim, as shown to the right.

The **Machine Sim Rendering** dialog box opens, as shown below.



Step 2: Select a machine model

Click the icon at the top right corner of the Machine Sim dialog to open the **Machine Sim Models** dialog box, shown below.

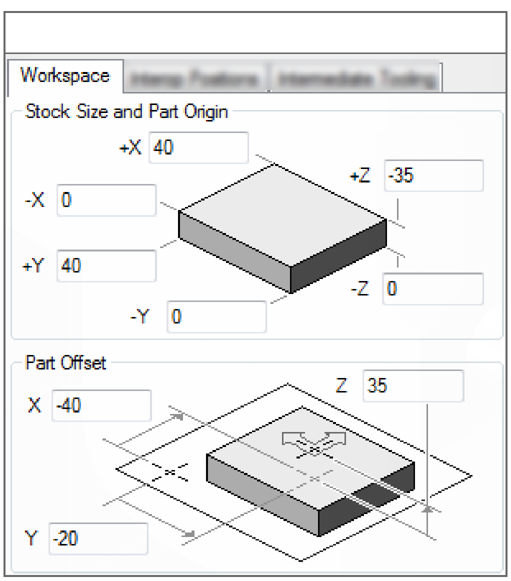


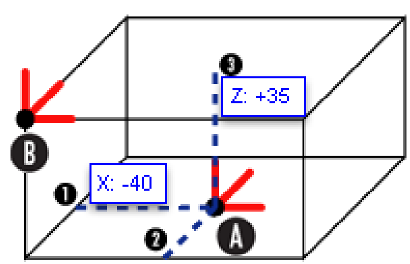
The **Machine Sim Models** dialog displays known machine assembly files. Select a machine from the list or click on the User Folder button to select a specific machine tool folder. The simulation window will open with the selected machine loaded.

The User Folder location is stored in each user's system preferences. The machine model name is stored with the associated part file.

Step 3: If Necessary, Update Part Offset in DCD

If needed, open the Document Control Dialog (DCD) and use its Workspace tab to view and possibly adjust the origin of the part to match that of the machine assembly file. These are absolute values in part units *from* the machine origin *to* the part origin.





(A) Table Origin at center bottom of this stock.

(B) Part Origin:

1. Negative X Value
2. Negative Y Value
3. Positive Z Value

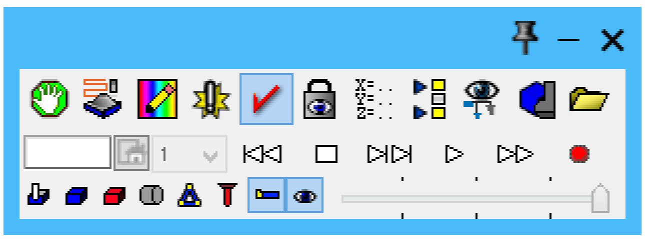
Part Offset example 1 (generic 3-axis mill): Part Offset places part origin (X0 Y0 Z0) left of, closer than, and above table origin.

Step 4: Select Rendering Options

Use the controls on the **Machine Sim Rendering** dialog, including the pop-up context menu available by right-clicking its title bar, to select the options you would like to use during rendering. For details, see “ Simulation Rendering Options” on page 44.

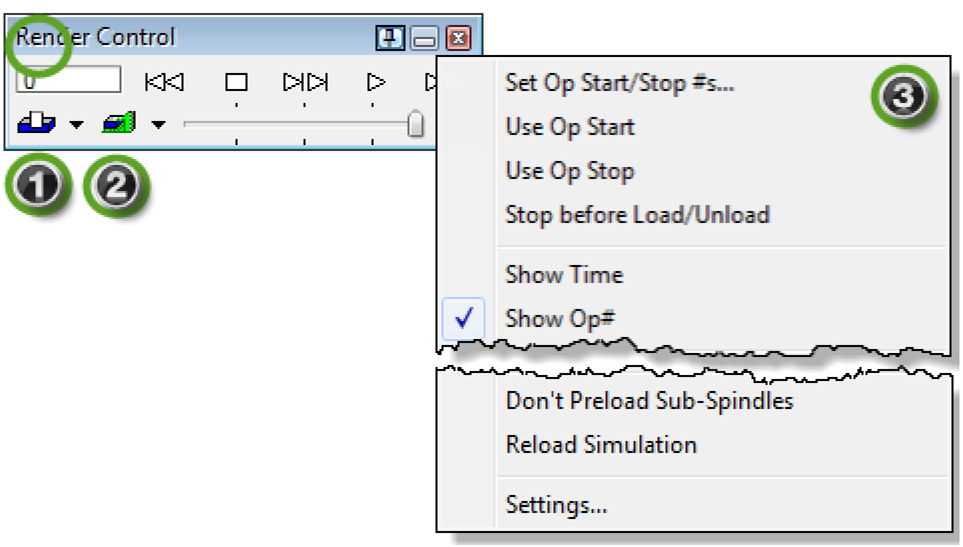
Step 5: Run the Simulation

To simulate operations, select the operations you want to simulate, and then use the simulation buttons.



Machine Sim Interface

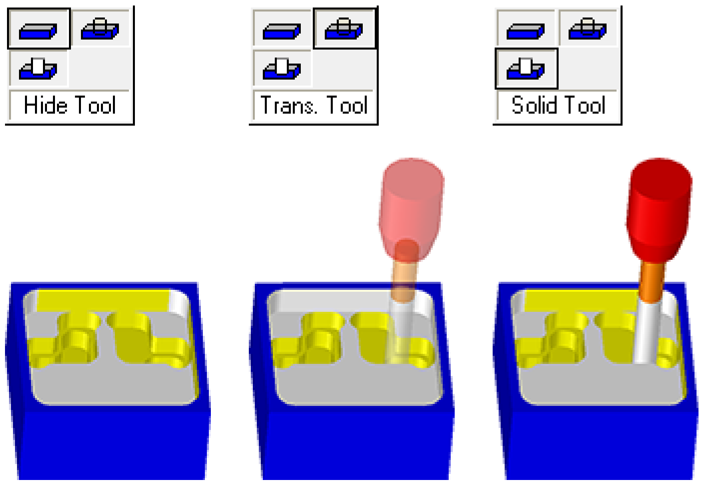
The basic interface for Simulation is not very different than the standard GibbsCAM Render Control palette. In fact, the interface is still called Render Control. The differences are the addition of two pull-down selections on the bottom of the palette (Tool Display and Run Mode) and the options in the menu. Also different are the results of the rendering. The rendered image is an OpenGL-based 3D part capable of zooming, panning and rotating without restarting the render.



1. Tool Display
2. Run Mode
3. Render Control menu

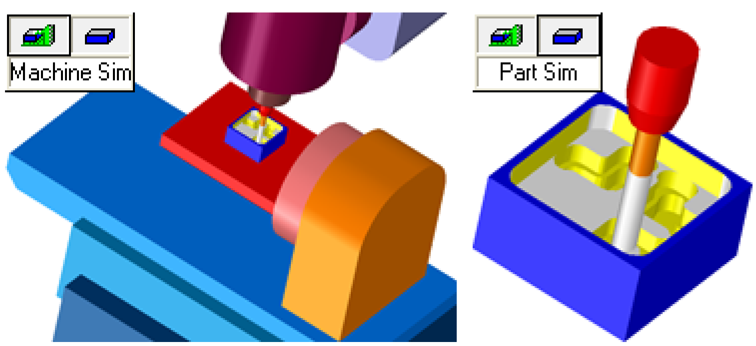
Tool Display

The Tool Display option is similar to the traditional rendering option of showing an invisible tool, a transparent tool or a solid tool. As with standard rendering, the hidden tool produces the fastest rendering while the solid tool is the slowest of the options.



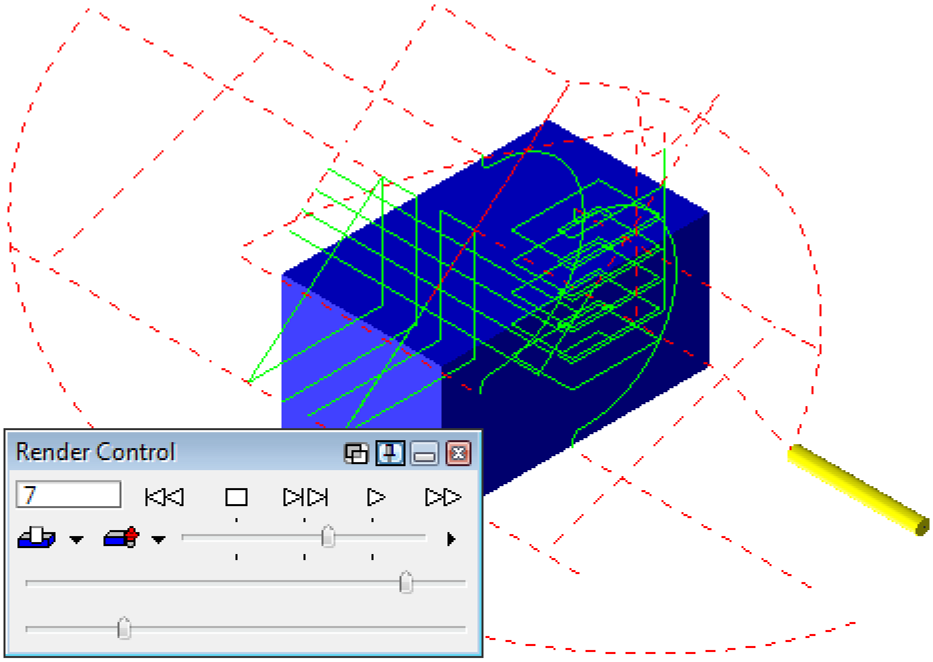
Run Mode

The Run Mode option shows whether Simulation will display the full machine model and part (Machine Sim), show only the part (Part Sim) or show the toolpath on the stock (Tool Sim).



To use Machine Mode a machine file will need to be selected using the Load Machine option in the Render Control menu. If your MDD correctly defines the ToolGroup and Workpiece home positions Simulation can be run in Machine mode without loading a machine file. In Machine mode to aid in the visualization of lathe spindles, the spindle will rotate while cutting during any lathe turning operation. This rotation is only to assist in showing the direction of rotation.

In Tool Sim mode, the Render Control has two additional sliders. As with other render modes, the first slider (from top to bottom) controls rendering speed. The second slider moves the tool back and forth through the render process with a fairly coarse granularity. The third slider provides a much finer granularity of control. The Simulation Rendering Options options control the display of the toolpath.



An example of ToolSim. The green lines are the traced toolpath and the orange lines are the rapid moves.

Render Control Menu

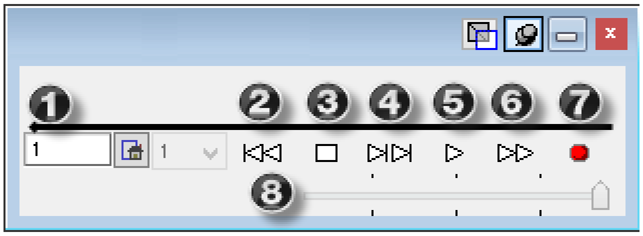
This menu provides control over the appearance and content of the Simulation rendering. The Render Control menu is largely the same as the standard and Flash CPR rendering modes. The options in this menu are fully detailed in Simulation Rendering Options.

Simulation Rendering Options

The **Machine Sim Rendering** dialog offers many kinds of controls, many of them identical to controls found in other types of rendering, such as Op Sim or Tool Sim.

- Playback Controls
- "Record Video" on page 45
- "Visibility Controls" on page 46
- "Simulation Control Icons" on page 49
- "Simulation Context Menus" on page 58

Playback Controls



1. Current Display
2. Rewind
3. Stop
4. Step Forward
5. Play
6. Next Operation
7. Record (not Legacy CPR)
8. Speed control

Note: If you click the Stop or Step Forward button to pause the rendering, and then close and redisplay the Render Control palette, rendering pauses at the same location. The system remembers where you pause the rendering. Click the Play button to continue rendering.

Current Display
This box displays the number of the current operation being rendered or the current runtime.

Rewind
Click this button to return playback to the first operation.

Stop
Click this button to pause rendering.

Step Forward
Click this button to render the next feature of the current operation, and then pause.

Play
Click the Play button to render the part from the current feature of the current operation in the Current Display box. Rendering continues until you click another button or the last feature of the last operation renders. The Stop and Step Forward buttons pause the rendering. If you click the Play button during rendering, the rendering pauses. The Next Operation and Rewind buttons change the current operation being rendered, but do not stop the rendering process. When the last feature of the last operation is complete, rendering stops. If rendering is paused, you can click the Play button to resume.

Next Operation
If rendering is in progress, clicking Next Operation finishes rendering the current feature, skips the remaining features for that operation, and continues rendering the next operation. If rendering is paused, clicking Next Operation advances the operation number in the Current Display box to the next operation. Click the Play button to continue rendering.

Speed Control
Shows the current location of the Speed Control slider. The Speed Control slider sets the speed of rendering. You drag the speed control slider to the left to slow the rendering speed or to the right to increase the rendering speed. You can drag the slider while rendering is in progress and the rendering speed adjusts accordingly.

Record Video

For all rendering modes except Legacy CPR, an additional red button is provided. Clicking it opens a dialog that lets you save the current simulation as a video file. The output video can then be played and viewed independently of GibbsCAM.

Output File

You can designate the path and filename of the output file.

Record

Click this button to start recording the Machine Simulation video.

Encoder

From the pull-down list, you can choose one of the following video encoders:

- H.264 Video
- Windows Media Video 7
- Windows Media Video 8
- Windows Media Video 9
- SMPTE 421MVideo

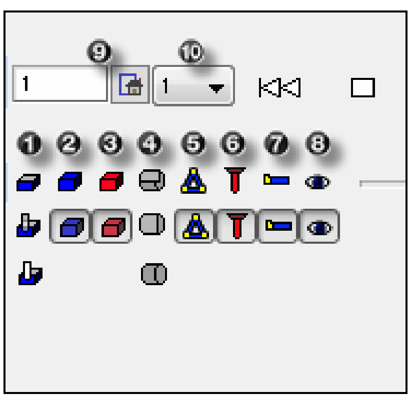
Frame Rate

Set the speed of the output video, in terms of how many frames to capture per second.

Video Dimensions

Set the width and height of the output video, either by entering the number of pixels or by using the current window view size.

Visibility Controls



1. Tool Visibility Control
2. Stock Visibility Control
3. Fixture Visibility Control
4. Lathe Stock Cutaway
5. Overlay Geometry
6. Show Rapid Tool
7. Show Tool Holders
8. Show Machine
9. Run time or Number of Operation Display
10. Active Flow Number

Tool Visibility Control

(Available for Operation, Tool, Machine Simulation, and Legacy CPR)

As with standard rendering, the hidden tool produces the fastest rendering; the solid tool is the slowest of the options.

 Invisible Tool:

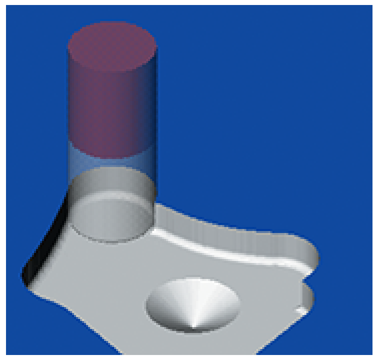
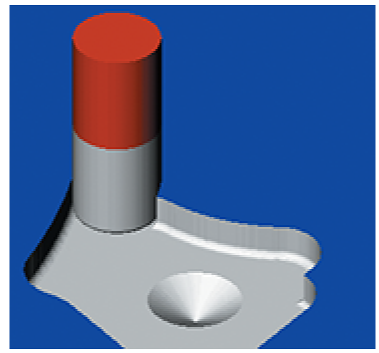
If this button is selected, the tools do not appear during the rendering process, although the material as a result of the tools cutting is removed (see example). Radii render more smoothly, and the part renders faster with this choice selected.

 /  Transparent Tool:

If this button is selected, transparent tools appear during the rendering process.

 /  Visible Tool:

Select this button to display opaque tools during the rendering process.

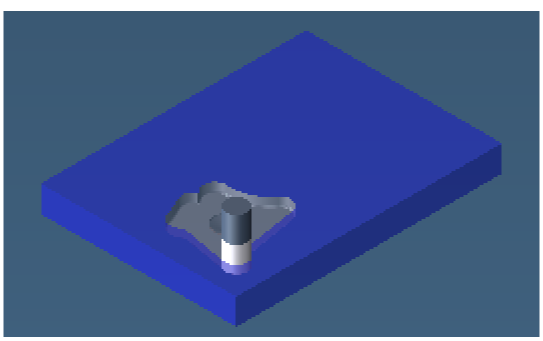
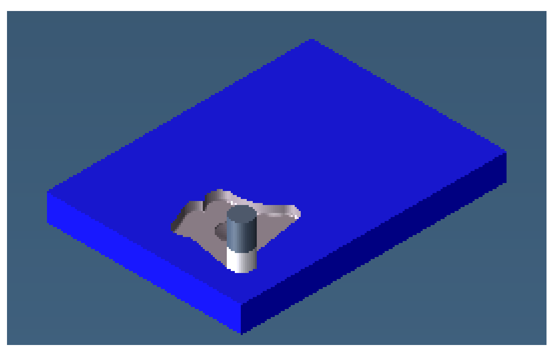




Invisible Tool	Transparent Tool	Visible Tool

Stock Visibility Control

(Available for Operation, Tool and Machine Simulation and Rapid CPR)

For Rendering, stock can either be displayed as Translucent  or Solid .

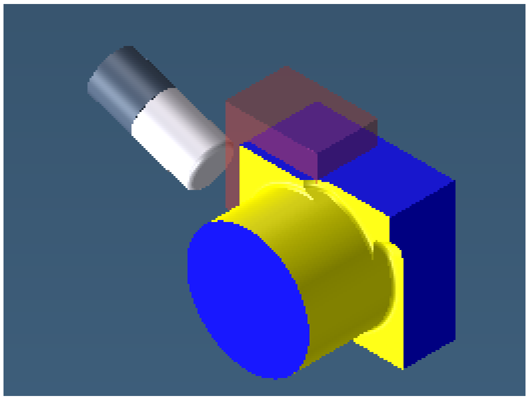
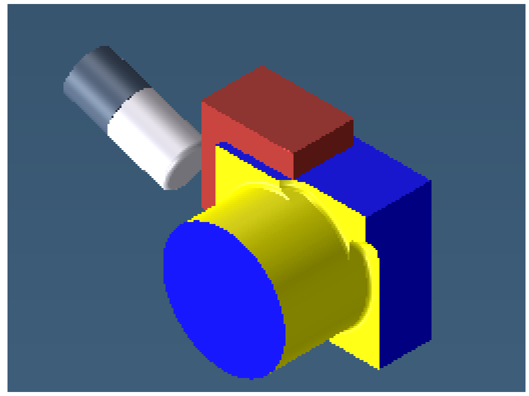



Translucent Stock	Solid Stock

Fixture Visibility Control

(Available for Operation, Tool and Machine Simulation and Rapid CPR)

For Rendering, fixtures can either be displayed as Translucent  or Solid .

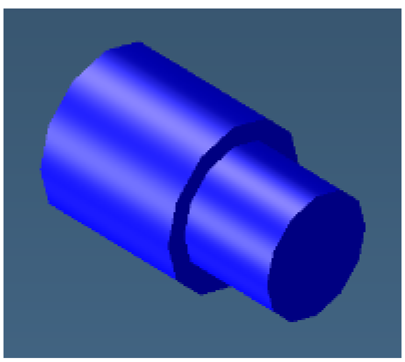
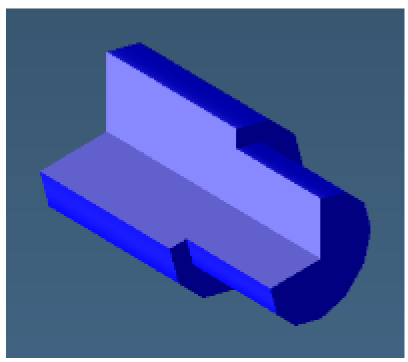
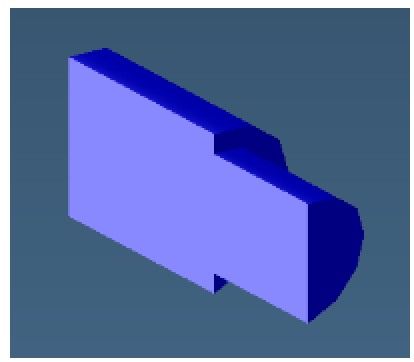



Translucent Fixture | Solid Fixture

Lathe Stock Cutaway

(Available for Operation, Tool, Machine Simulation and Legacy CPR)

When rendering parts in the Turning, Mill/Turn, or Multi-Task Machining modules, there are three cutaway states for the stock cut part rendering. The three cutaway states are: No cutaway; 1/4 cutaway; and 1/2 cutaway.

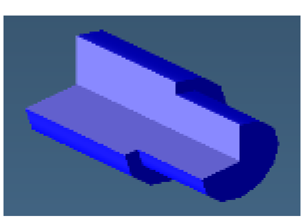
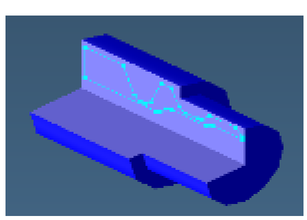
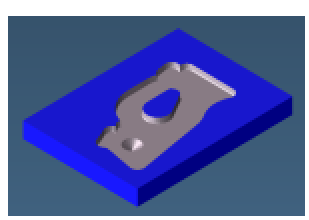
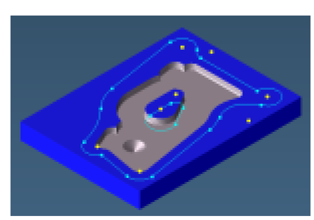




No cutaway | 1/4 Cutaway | 1/2 Cutaway

Overlay Geometry

(Available for all rendering options)

This option hides / shows workgroup geometry while rendering the part.

Turning: No Geometry | Turning Geometry | Mill: No Geometry | Mill Geometry

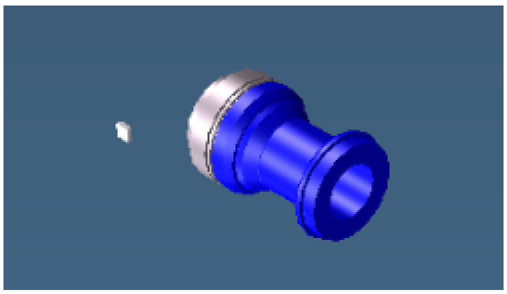
 **Show Rapid Tool**

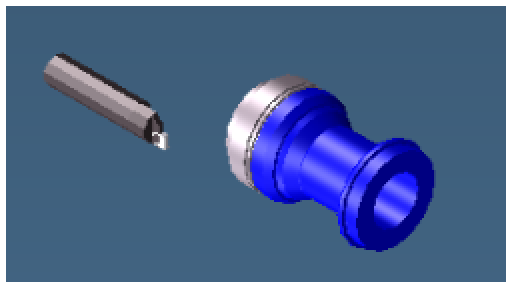
(Available for Operation, Tool and Machine Simulation)

The tool is rendered in a different color to show when it is Rapiding when this option is enabled.

 **Show Tool Holders**

(Available for Operation, Tool, Machine Simulation and Legacy CPR)





No Toolholder	Show Toolholder

 **Show Machine**

This option is only available in Machine Sim Rendering.

 **Run time or Number of Operation Display**

(Available for all rendering modes)

This displays the current run time or Operation number. If the rendering is stopped, the display is the time it was stopped or the number of the previous operation. A value of zero means that rendering has not yet begun.

Available on the Machine and Operation Rendering, the central "home" button, when clicked, aligns the active Flow cutting plane to the home view.

Active Flow Number

The second dropdown box, on the right hand side, available for all Rendering modes except Legacy, is to select the active flow display.

Simulation Control Icons

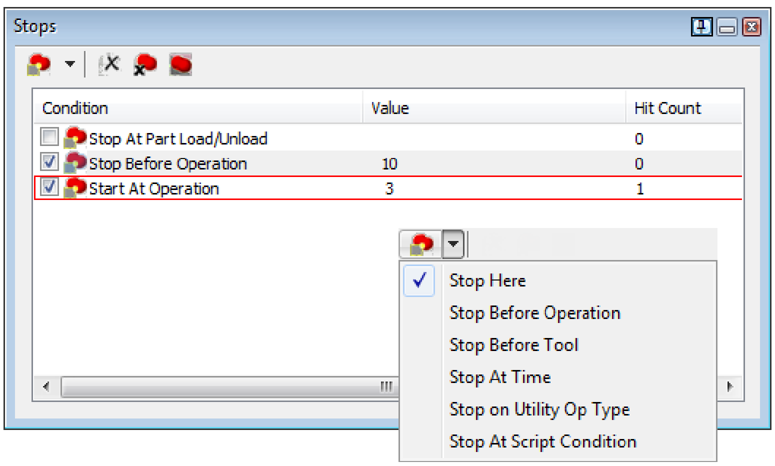
The Rapid, Part, Tool and Machine Simulation palettes have various control options. To select an option, click on the icon. In many cases, more than one icon can be selected at once.

Stops

(Available for Rapid, Operation, Tool and Machine Simulation)

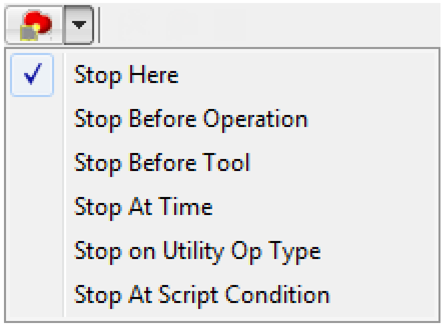
Selecting this command allows you to set a point before which the rendering should stop. Use the checkbox to add/deselect options. Rendering will stop after completion of the condition before the number specified in the dialog.

Three stop options appear on the initial page. Select a stop using the checkbox, then double-click the option to input conditions. All options except for "Stop at part Load/Unload" provide a window to input specific operation/tool numbers, times, and so forth. When a stop is active it is highlighted with a red box as shown below. If multiple stops have been set, use the Play button to go to the next stop.



Stops dialog

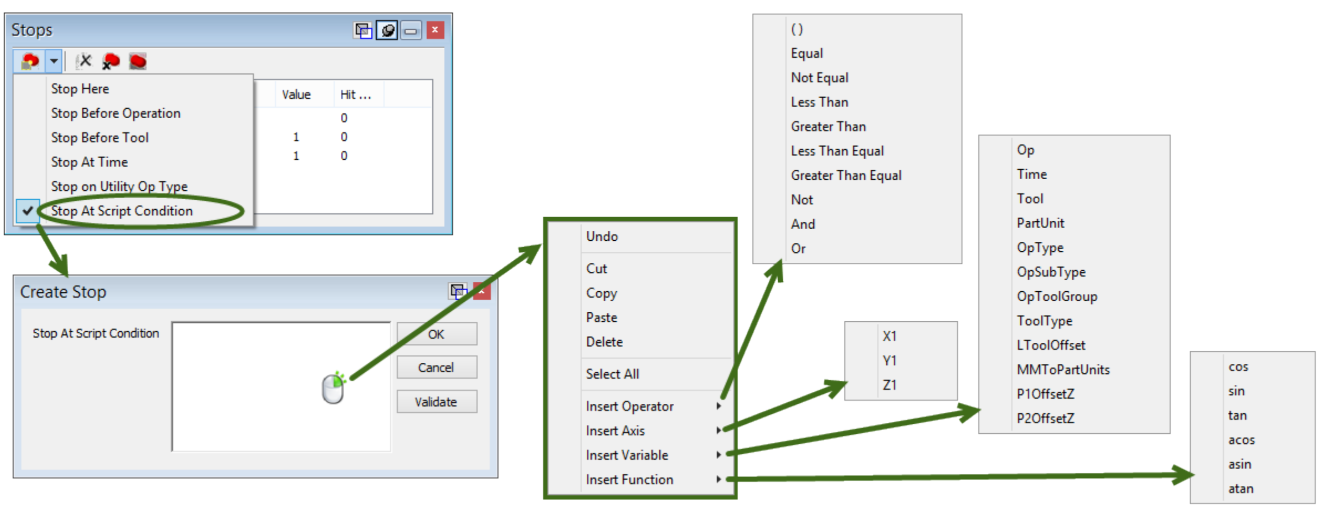
1. Stop Drop-down menu
2. Delete Selected Stops
3. Delete all Stops
4. Enable/Disable selected stops
5. Import Stops (`*.smd` file)
6. Export Stops (`*.smd` file)



(1) Drop-down menu items for **Stop** menu

Additional stop options can be chosen from the dropdown menu. Scroll down the menu and select the desired option, then input required values in the dialog window. The Stop at Script Condition option has a right-click menu within the input window, providing the opportunity to input more specific conditions. The Validate button will ensure there are no script parsing errors.

Stop at Script Condition Options



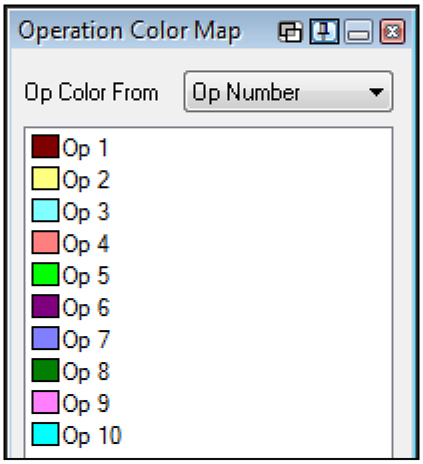
 Tool motion on target body

(Available for Operation and Machine Simulation)

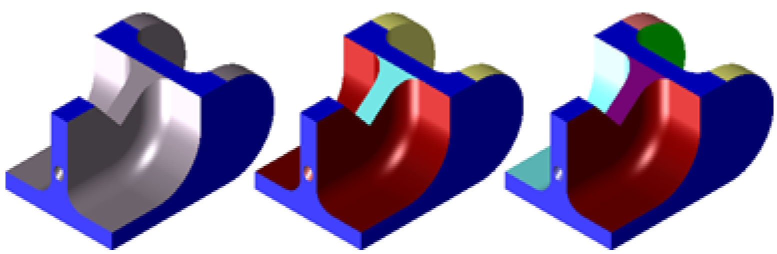
This option provides a non-cutting simulation of the tool motion. Selecting this option will increase the speed of the simulation, where the display of material removal is not as important as what the tool is doing.

Op Color Mode

(Available for Rapid, Operation, and Machine Simulation)



This option lets you use color to enhance the functionality of CPR and Simulation. The corresponding options sub-dialog has three color modes: Cut Color (the default behavior, matching earlier versions of the software), Tool Number, and Op Number. The color of the remaining material changes with each operation or tool. In this way, you can see what areas of the part were machined by each operation, tool, or selected op. The color palette is generated automatically to create a set of colors that are readily distinguishable from one another. Double-clicking a color allows you to change it.

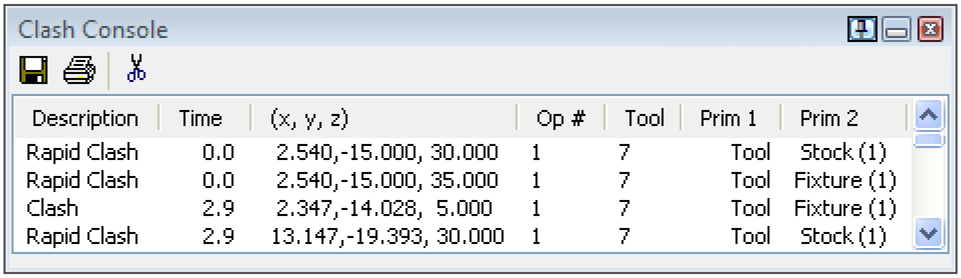


Example of Cut Color, Tool Number, and Op Number use

Collision Checking

(Available for Operation and Machine Simulation)

This option enables checking of collision events. The result of a collision event is controlled by setting the Collisions/Limits parameters. For details on these preference settings, see the documentation on File > Preferences > Display > Op/Tool and Machine Simulation Settings. If the Collisions/Limits is set to “Log To Display”, then a report detailing any “collisions” is generated. The report, which includes when the collision occurs (Time), the XYZ value of the collision (Location), the operation, and the tool, can be saved out as a text file. Additionally, the Prim 1 section details whether a Tool or Holder was involved. The Prim 2 section reports whether the collision was with Stock or a Fixture. Using this option will slow down rendering speed.


Clash Console

Description	Time	(x, y, z)	Op #	Tool	Prim 1	Prim 2
Rapid Clash	0.0	2.540,-15.000, 30.000	1	7	Tool	Stock (1)
Rapid Clash	0.0	2.540,-15.000, 35.000	1	7	Tool	Fixture (1)
Clash	2.9	2.347,-14.028, 5.000	1	7	Tool	Fixture (1)
Rapid Clash	2.9	13.147,-19.393, 30.000	1	7	Tool	Stock (1)

Program error checking

(Available for Rapid, Operation and Machine Simulation)

This setting checks for any axis motion that is beyond the limits set in any machine component. If an axis limit is exceeded, a collision event is generated in the same way that it is generated when two components collide. The result of an axis limit exceeded event is controlled by the Collisions/Limits settings in the Simulation Settings dialog.

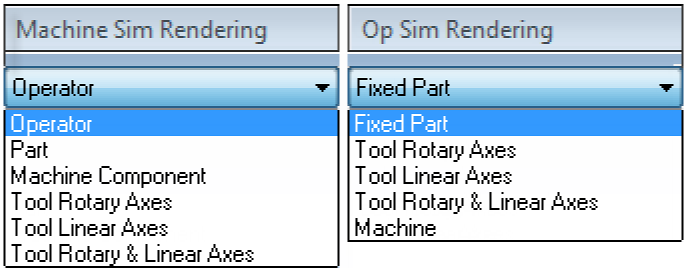
Please note that a Program error message will be displayed if axes are not properly set up or are missing in Machine Manager, even if this option is not enabled.

Point of View Lock

(Available for Operation and Machine Simulation)

This gives you control over how the virtual camera moves around the scene, defining the point of view during animation. The element chosen to be locked then becomes fixed in position.

The choices available for Point of View Lock will be different depending on the rendering mode.



- Operator (Machine Sim) Fixes the view to outside the machine.

- Part/Fixed Part - (Machine/Op Sim) enables a pull-down menu to select the spindle to use to sync the simulation. GibbsCAM will focus on the stock, and the tools and machine will rotate around the part.

- Machine (Op Sim) This shows the viewpoint from within the Machine. It is similar to Fixed Part, but shows stock moving/rotating. Tools do no move around it.

- Machine Component (Machine Sim) Locks the view to a particular machine component. Choose from the pull-down menu which component is to remain stationary during simulation.

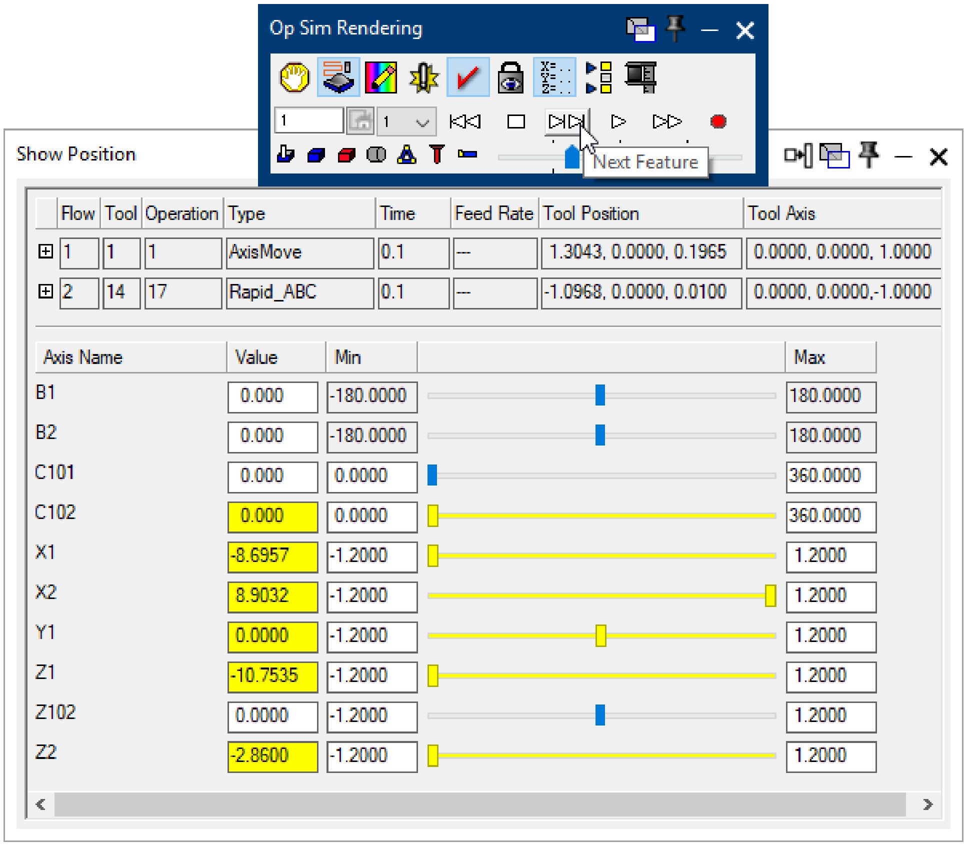
- Tool Rotary/Linear Axes (Machine/Op Sim) The view will lock on the Tool and its movements along the chosen axis.

Show position

(Available for Tool, Operation and Machine Simulation)

This option opens a dialog box showing continuous tracking of axis motion and current feature information. Sliders allow you to explicitly move machine axis. The **Render Tracking** dialog summoned by the Machine Sim Rendering palette might display more axes than the **Test Machine** dialog (in Machine Manager), which shows only the axes that are available in the kinematic tree. The Machine Sim **Show Position** dialog can potentially also display axis motion for custom axes defined by a VMM or by a script, such as for a Z601 axis for a bar loader.

For easy visualization, when you press ▷I▷INext Feature, in the **Rendering** dialog, the **Show Position** dialog shows the axes that move by changing the color of their values and sliders.



Skip Unselected Ops

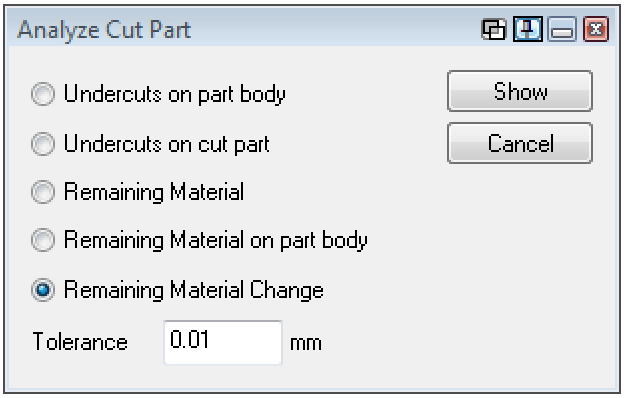
(Available for Rapid, Operation, Tool and Machine Simulation)

This option will only render the currently selected operations. (The other operations are still generated.) This option reduces the rendering time.

Analyze Cut Part

(Available for Rapid and Operation Simulation)

The Analyze Cut Part dialog provides several options to determine the results of the toolpath on a rendered part. This is an easy way to determine if there are areas on a body that are not being machined (Remaining Material) or if any cuts violate the part. You must select a solid prior to starting Simulation to use the Analyze Cut Part option.



Trace Options

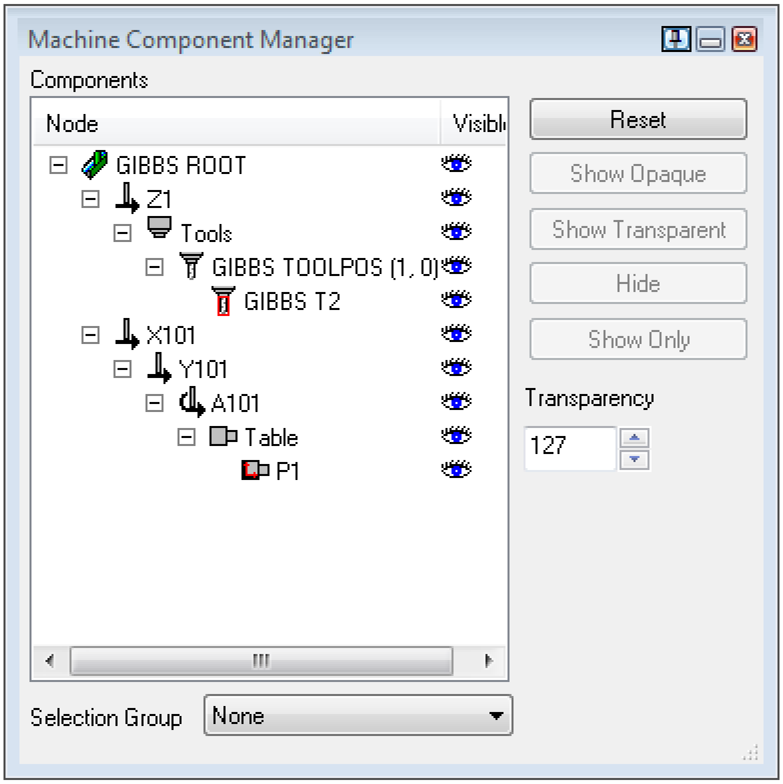
(Available for Tool Simulation)

This option let you choose how much of the toolpath will remain on the screen – 0%, 1%, 5%, or 100% of the toolpath – as the tool follows the toolpath. `Trace Operation` will draw one operation at a time. `Trace From Run` will clear the previous toolpath and begin redrawing if the user stops the render midway through and restarts.

Machine Component Visibility

(Available for Machine Simulation)

This option opens a dialog box allowing control of the visibility of components in the machine assembly file. You can control the components individually and/or by the groups set in Build Machine. The eye icon lets you show or hide a component. Additionally, you can set a specific transparency level from `0` (invisible) to `255` (solid).



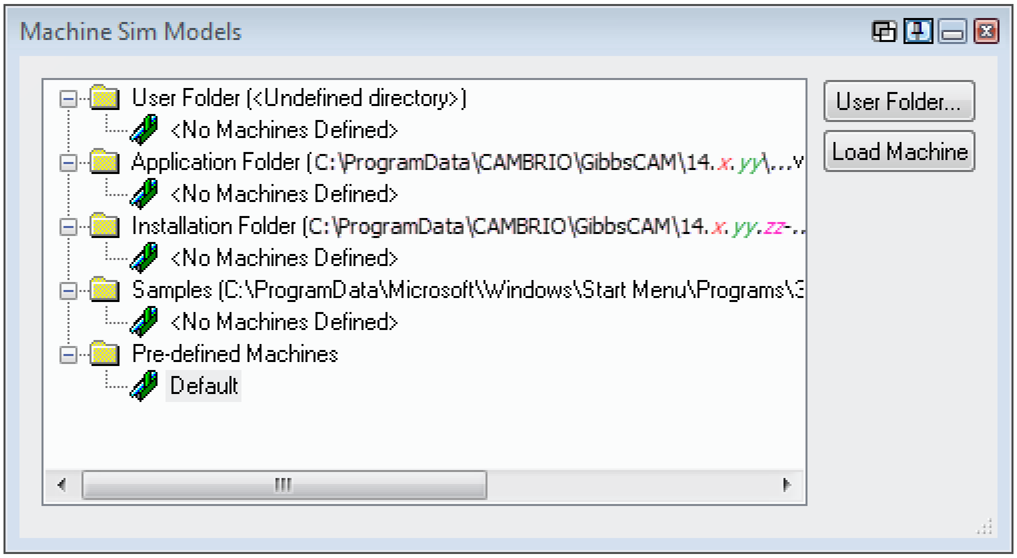
 Don't Block Stock

(Available for Machine Simulation)

Don't Block Stock is a rendering mode that renders all fixture bodies that appear in front of the stock bodies as transparent. This lets you see material removal on stock bodies even when some other bodies move in front of them.

 Load Machine

(Available for Machine Simulation)



This option allows you to select which machine assembly file will be used for the current part. Once selected, the same machine will automatically be used for the part until a different machine is selected. Clicking User Folder allows you to select a directory that contains machine assembly files. Select the machine you wish to use and then click OK.

Simulation Context Menus

Show Time

This will set the Current Display to show the elapsed cut time.

Show Op

This will set the Current Display to show the current operation number.

Render Loop

Replays the simulation until the user presses the stop button.

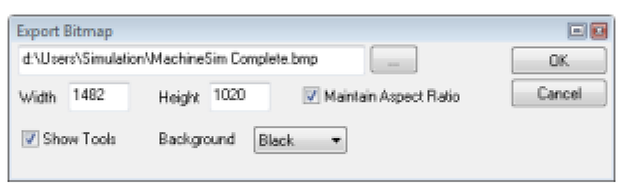
The following options are only to be found in the Simulation dropdowns:

Save to STL

Select this option to save a copy of the simulation to an .stl file for viewing later.

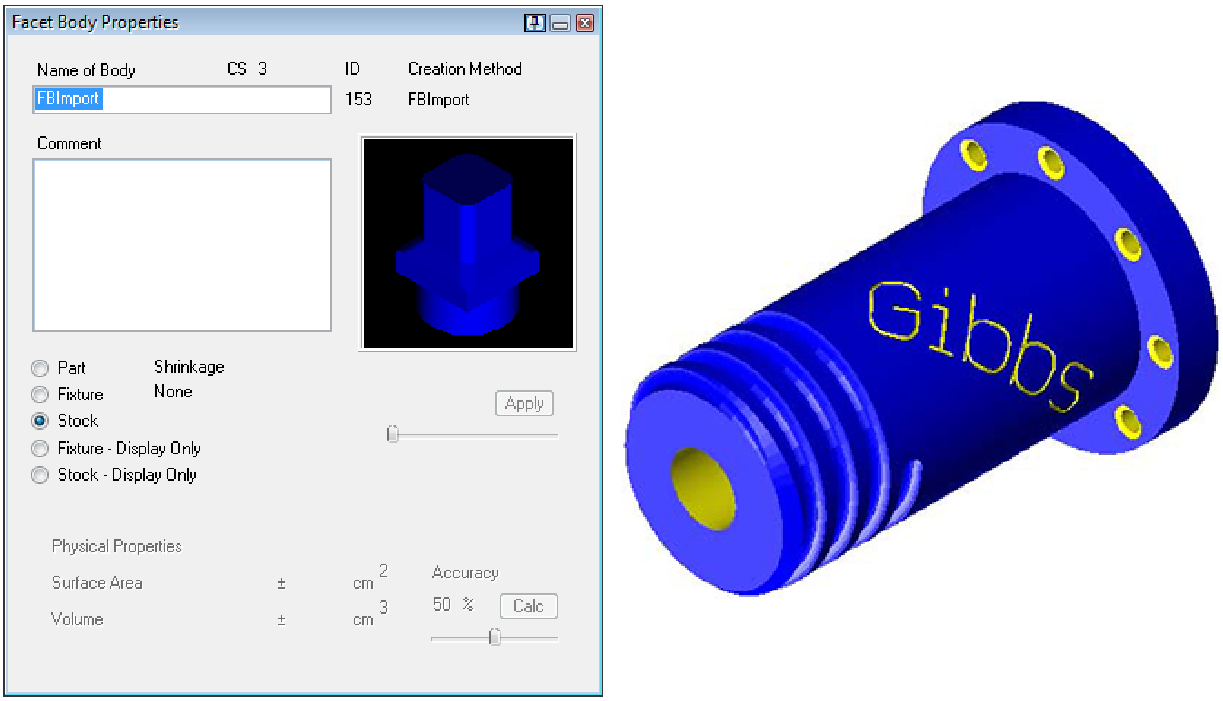
Save to Bitmap

Select this option to save a copy of the simulation to a bitmap file. This will re-render your current state at the specified resolution and save it as a picture. Please note that most video cards will not support saving a picture over 4000x4000.



Create Facet Body

This function turns the current cut rendered condition into a facet body. The facet body will appear in the workspace as a transparent body. Facet bodies can be regarded as other solid bodies: They can be queried, profiled, sliced, and machined. One of the uses of facet bodies is that they can be set as stock for “display only” purposes, i.e. they are not used as a stock condition for creating toolpath but they can be shown in rendering. Setting a facet body as stock can be quite useful for saving a rendered condition so you can instantly get to later operations.



Example of a Facet Body used as stock.

Skip pecks

The Skip Pecks option does not render any pecking moves used in drilling operations. Pecking is still generated. This option simply reduces the rendering time.

Don't preload Subspindles

Disables sub-spindle stock generation. This improves performance with the tradeoff of not having accurate stock on the sub-spindle during the first run. Not available for Tool Sim.

Reload Simulation

This option reloads the simulation.

Skip Interop Moves

Switches off the display of inter-op moves. Available only for Op Sim.

Graphic Part Face Distance

For use with parts containing multiple spindles. When enabled, this will render simultaneous display of multiple spindles. Available only for Op Sim, and standard for Flash CPR.

Show Spinning Part

Displays a transparent solid that represents the stock spinning at high speed, projected over the subspindle stock. This transparent solid image is called a *spun outline*. This option is useful for visualizing stock that is asymmetrical or has deep concavities. It is not useful if the stock is simply a revolved profile, because the spinning stock is identical to the stock at rest.

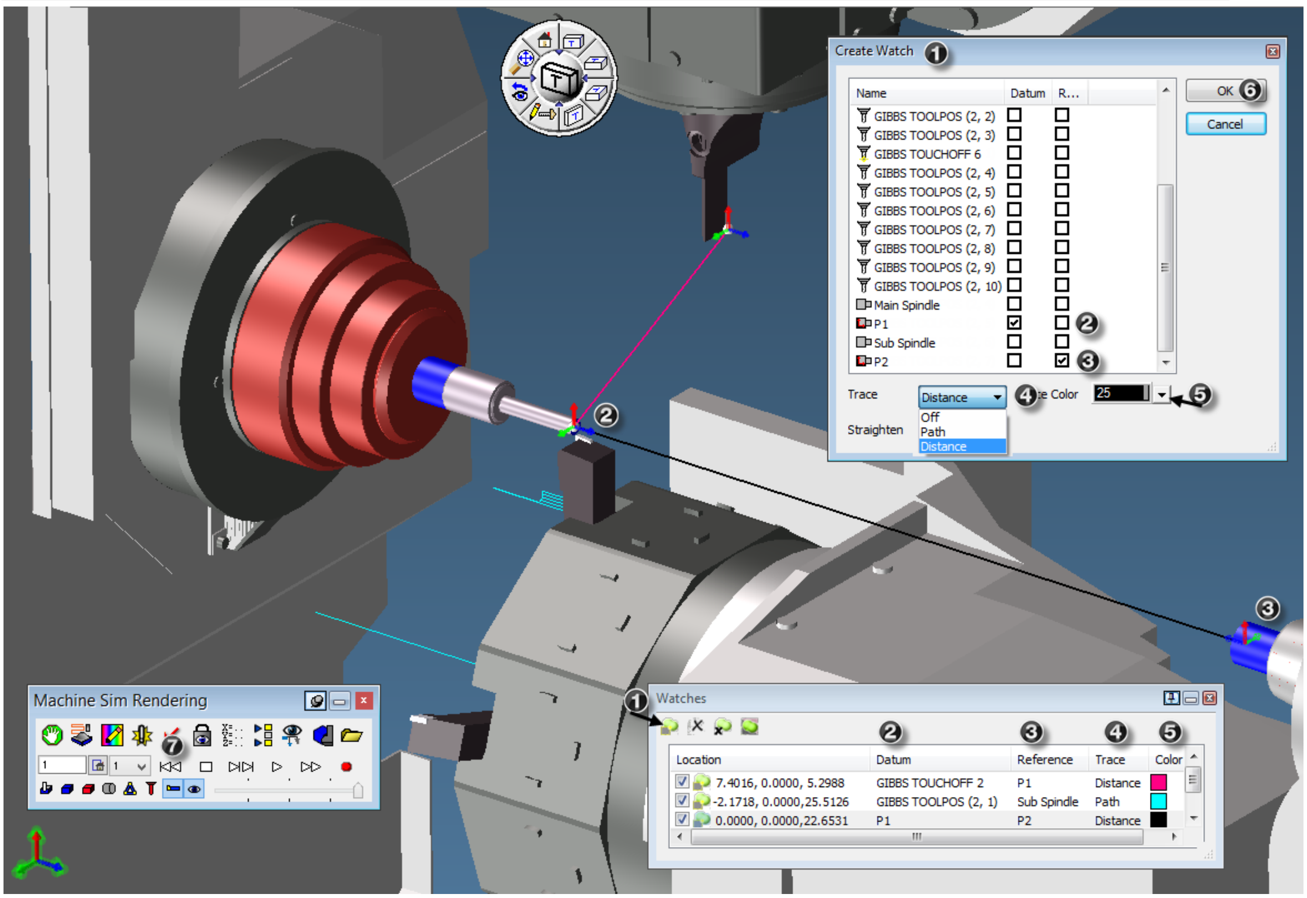
Watches

The purpose of the "Watches" function is to graphically display, trace, measure, and analyze the relationship and the location between chosen point A (Datum) and point B (Reference). These points can be set to almost any item defined in the current Machine Model. You can choose from the `Trace` dropdown either to track `Distance` between points or to trace the `Path` they take.

Multiple watch combinations can be created and displayed at the same time. You have the ability to differentiate them by `Trace Color`. To enable or disable watches, check or uncheck the checkbox. To edit a watch item, double-click it. You can import and export watches as `*.smd` files.

The location measurements are updated continually during rendering and are displayed on the `Watches` dialog. `Path` Trace lines are shown in the workspace in their chosen color, `Distance` lines also display an axis block at each end. Available only for Machine Sim.

Watch example



Steps to creating a Watch

1. Click the Create watch Icon in the `Watches` dialog. Result: The `Create Watch` dialog opens.
2. Set Datum
3. Set Reference
4. Set watch to either Path or Distance (or turn
5. Set color
6. Click OK. The `Create Watch` dialog closes.
7. Rewind Rendering and play. Path and Distance markers display in the Workspace. Location data displays in the `Watches` dialog.

Steps to creating a Watch	

Off)

Sample cut

Enables/Disables MachineWorks SampleCut technology. Sample cut is a new MachineWorks technology feature that minimizes memory used by simulating material removal at the expense of accuracy (material removal is accomplished using a 3D grid space instead of the standard facet-body booleans). This means that an application will only use a fixed amount of memory to render an arbitrarily complex toolpath which can be of benefit in particularly dense surfacing toolpath where users have traditionally run up to the memory limits of their computer.

Settings

This option opens the relevant Sim Settings dialog. There are separate dialogs for Op/Tool settings and Machine Sim settings. (Rapid cut uses the Op/Tool Simulation settings dialog.) Although both dialogs are essentially the same, they save separate data files. For details on these preference settings, see the documentation on File > Preferences > Display > Op/Tool and Machine Simulation Settings.

Tools

Setup

Understanding how to properly set up tools and positions is vital to getting Machine Sim to render correctly. This section discusses defining tools for Machine Sim.

This section explains how one machine's toolgroup was set up. The machine is a relatively standard two turret two spindle MTM-type machine. The MDD for this machine will handle the tool holder length so the user will not have to calculate the tool tip's distance from the mount point. The Use Tool/Holder Length value in the MDD can be set to X`0`, Y`0`, Z`0` because the mount point is known and specified in the Build Machine Setup (see below). The machine assembly file has been defined with all of the components referenced from the machine CS (#1 in the image below). The turret is defined in the Add Component dialog box as a rotary axis, and the rotation point (#2 below) is referenced from the machine CS. The turret's datum point or mounting point for tools (#3 below) is set in the Setup dialog box. The point can be set and seen by clicking on the From Selection and Show buttons.

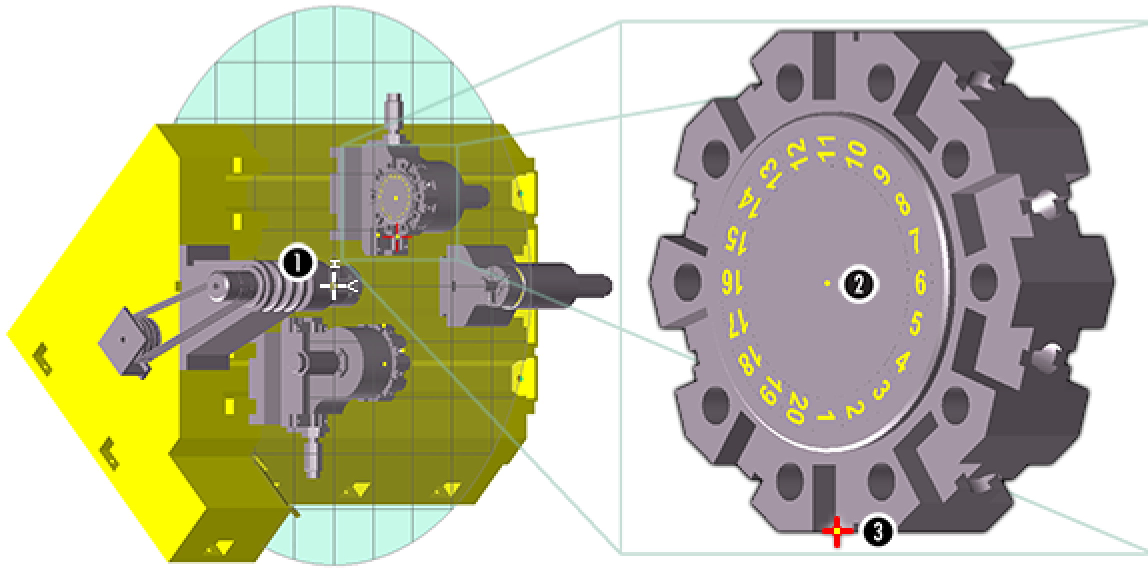
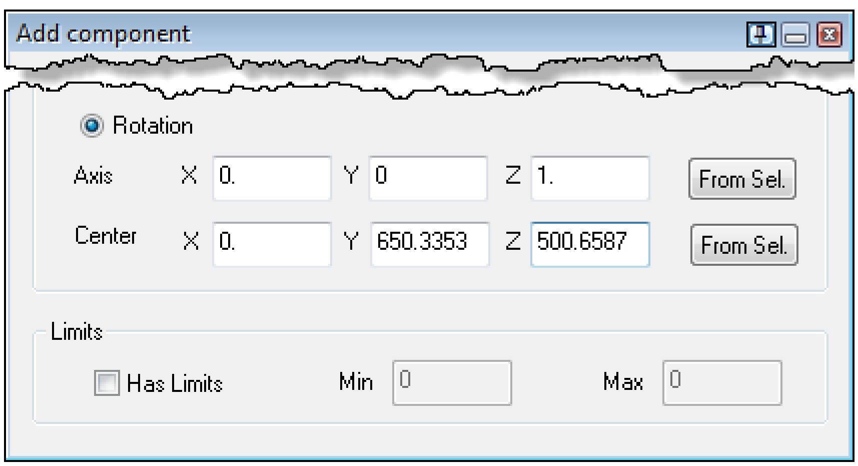
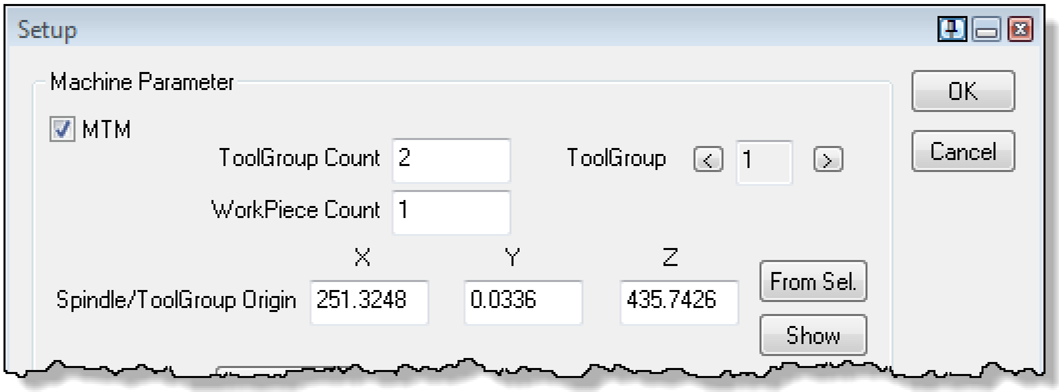


Illustration of the example setup.

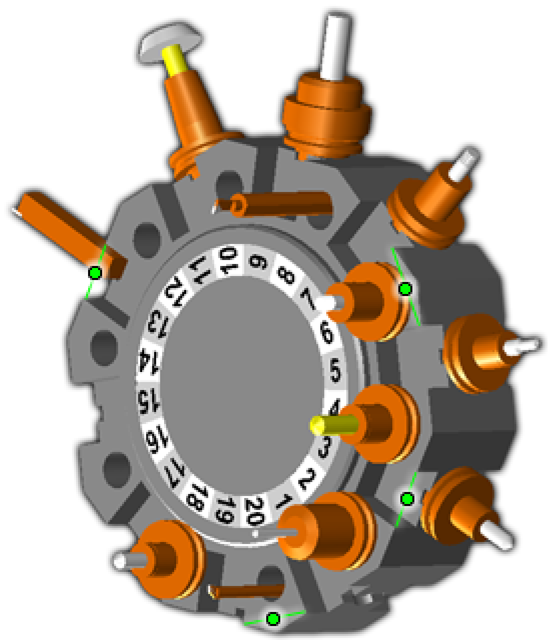


The turret’s center of rotation definition.



The tool's mounting point on the turret.

This discussion addresses four basic tool setups: mill OD and Face orientations and lathe OD and Face/ID orientations. The image to the right is an example of the turret as rendered in Machine Sim with the tools fully set up. We will focus on tools #3 (an OD drill), #6 (a face-oriented mill thread tool, #13 (a cut-off tool) and #20 (an ID oriented insert).



A point has been added at the approximate location of each tool position that represents the Spindle/ToolGroup Origin (also referred to as the datum point) when that tool is in position to cut. Any tool shift information is made relative to this point. Looking back at the illustration for we can see more clearly that the datum point floats in the space for a tool holder or on the face of the turret, depending on the tool. We can also see that face-oriented tools will need to be offset in Xr to be in place while the OD oriented tools will need to be offset in Z. Additionally, other offsets or turret shifts may need to be applied.

Mill Toolgroups

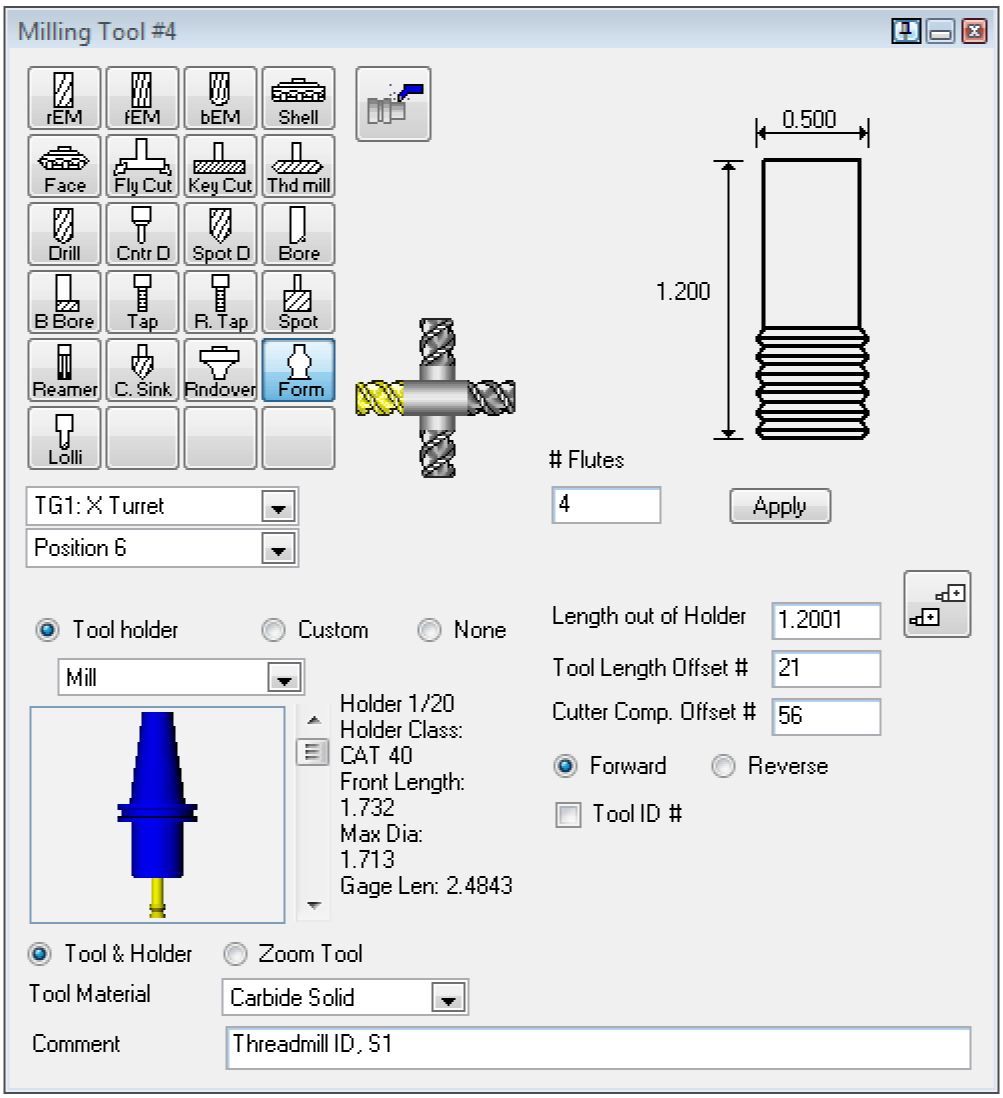
Tools are attached to a mill toolgroup during machining when the tool becomes the active cutting tool. The tool is positioned at the location defined by setting the Spindle/ToolGroup Origin in the Setup dialog box.

For mill toolgroups, the tool should be offset in Z only. There are two methods to define the Z offset of a mill tool. One method is to use the tool Z offset value from the tool dialog, meaning the length out of holder plus the distance the tool holder sticks out of the toolgroup. The other method is to let machine simulation calculate the Z offset by using the tool holder length and the “Length Out of Holder”.

To enable machine simulation to calculate the Z offset for tools in a mill toolgroup, there is a setting in the MDD that must be turned on. This setting is called "Use Tool / Holder Length" and is one of the toolgroup settings in the MDD. When this option is checked the tool and holder (if available) are positioned so that the tool and holder stick out from the spindle at the spindle face. The tool shift offsets are applied from that default position. If the option is not checked then the tool tip center is shown at the spindle face, offset by the tool shift offsets.

Mill Tools - Face

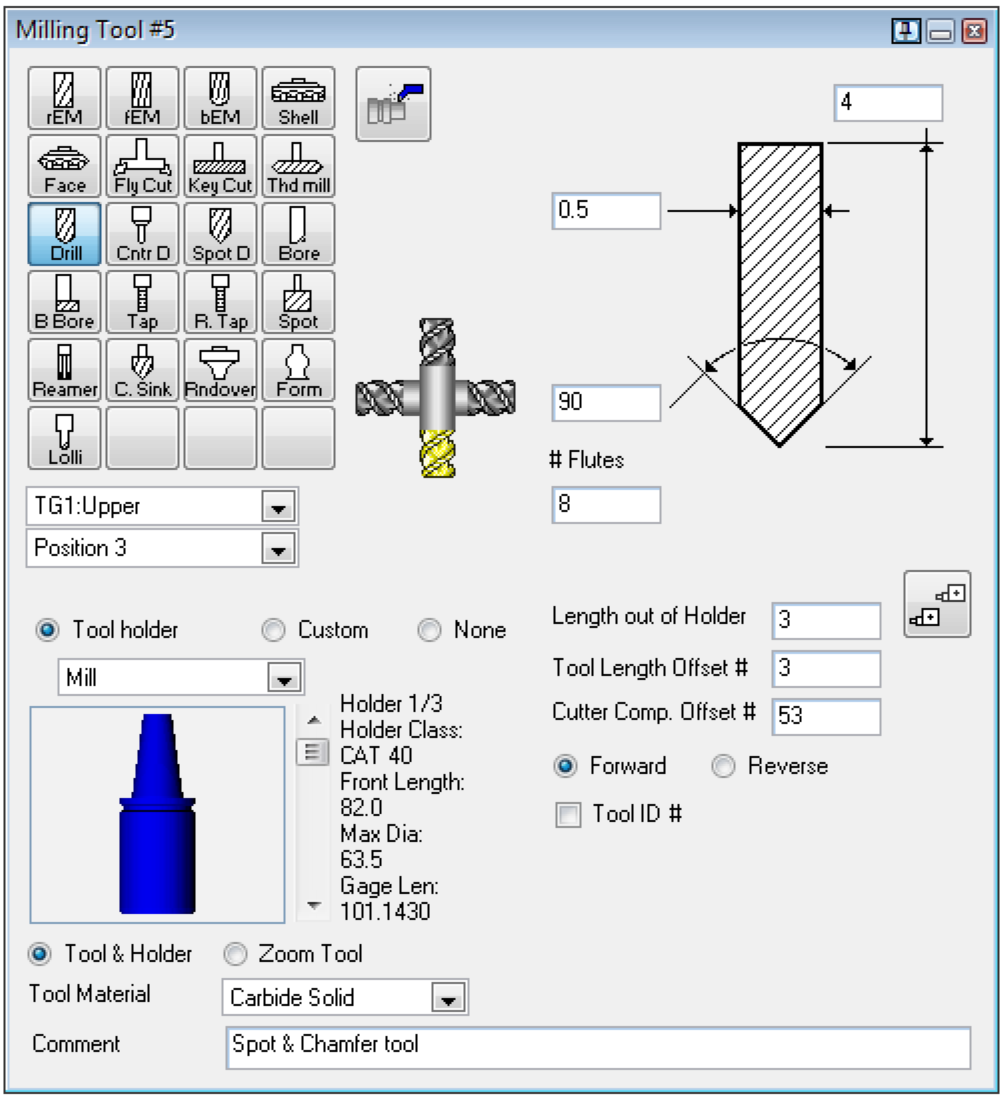
To explain Mill - Face, we use the tool in position #6 as an example. In order to get the tooltip in the correct location, we need to apply a tool offset value. The distance from the datum point to the center of the mount hole is 30mm or 1.181 inches. In the Tool offset data dialog we enter an Xr offset value of `-1.181`.



If we were not using the MDD's capability of calculating the tool andholder length we would also need to add a Z offset. The tool length out of the holder is 1.2 inches and t has a tool holder of some length. We would need to know the gauge length of the holder to calculate the Z offset properly. In the Tool offset data dialog we would enter an Xr offset value of `-1.181` and a Z offset of `1.2+(gauge length)` inches.

Mill Tools - OD

To explain Mill - OD, we use the tool in position #3 as an example. In order to get the tooltip in the correct location we need to apply a tool offset value. In this case, as the hole for the holders is OD aligned, we will need to offset the tool in Z. The distance from the datum point to the center of the mount hole is 50mm or 1.9685 inches. In the Tool Offset data dialog we enter an tool offset value of `-1.9685` in Z.



Lathe Toolgroups

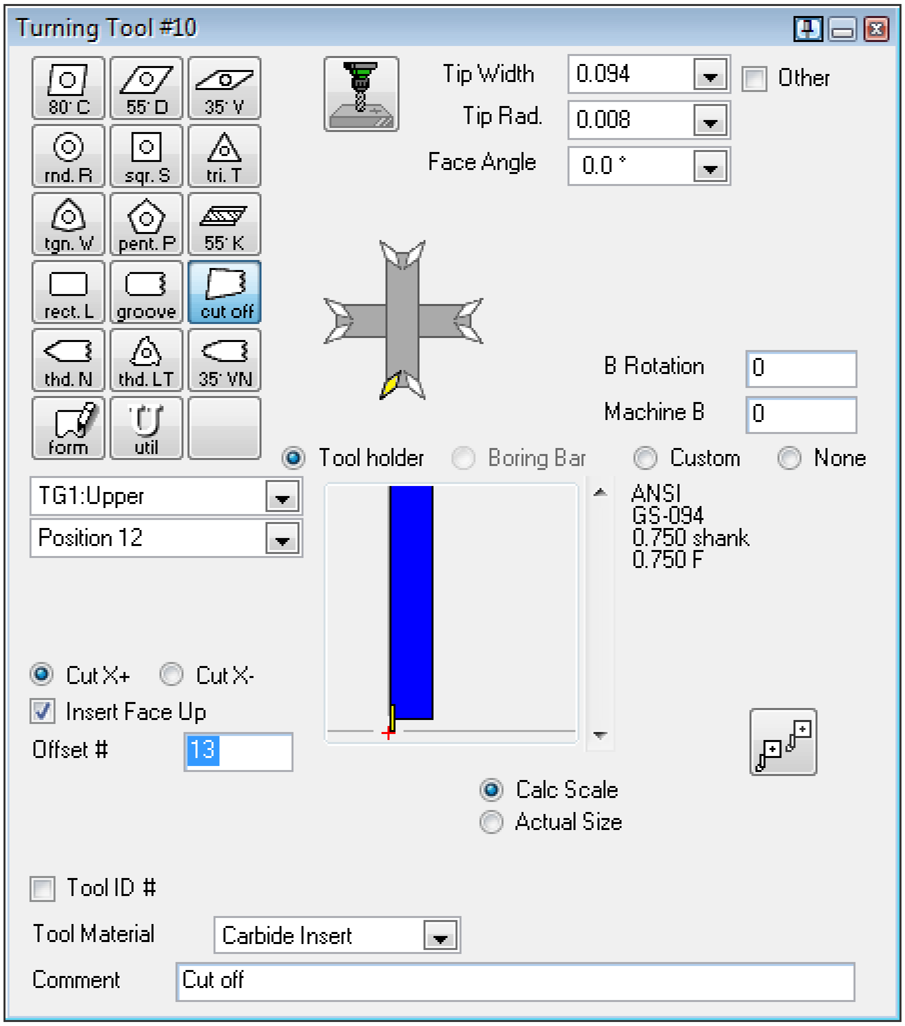
Tools are attached to a lathe toolgroup during machine simulation as a result of the information in the tool dialog. The tool dialog holds the toolgroup number and the tool position within the toolgroup. In the Setup dialog, enabling the Has Turret option activates the tool position definition. This allows the machine assembly to store information about the tool positions in a toolgroup. Each position is numbered, and the position number is matched to the tool dialog position numbers to display each tool in the proper position.

The tool is attached to the toolgroup so that when the tool's position is moved into place for cutting, the tool is at the tool attachment position of the toolgroup. This attachment position is defined by using the Spindle/ToolGroup Origin setting in the Setup dialog box.

The tool offset values from the tool dialog is used to adjust the tool position in the toolgroup from the tool attachment position. This means that if the tool offset values for a given tool are set to zero, the tool control point (typically the tool insert tip) is displayed at the tool attachment position. A common place on the toolgroup for the tool attachment position is the corner of the turret closest to the spindle that the toolgroup will address during machining. The tool offset values are used to position the tool tip at the correct offset from the tool attachment position, considering the length and width of the tool holder and any tool adapter block or live tool assembly that is required.

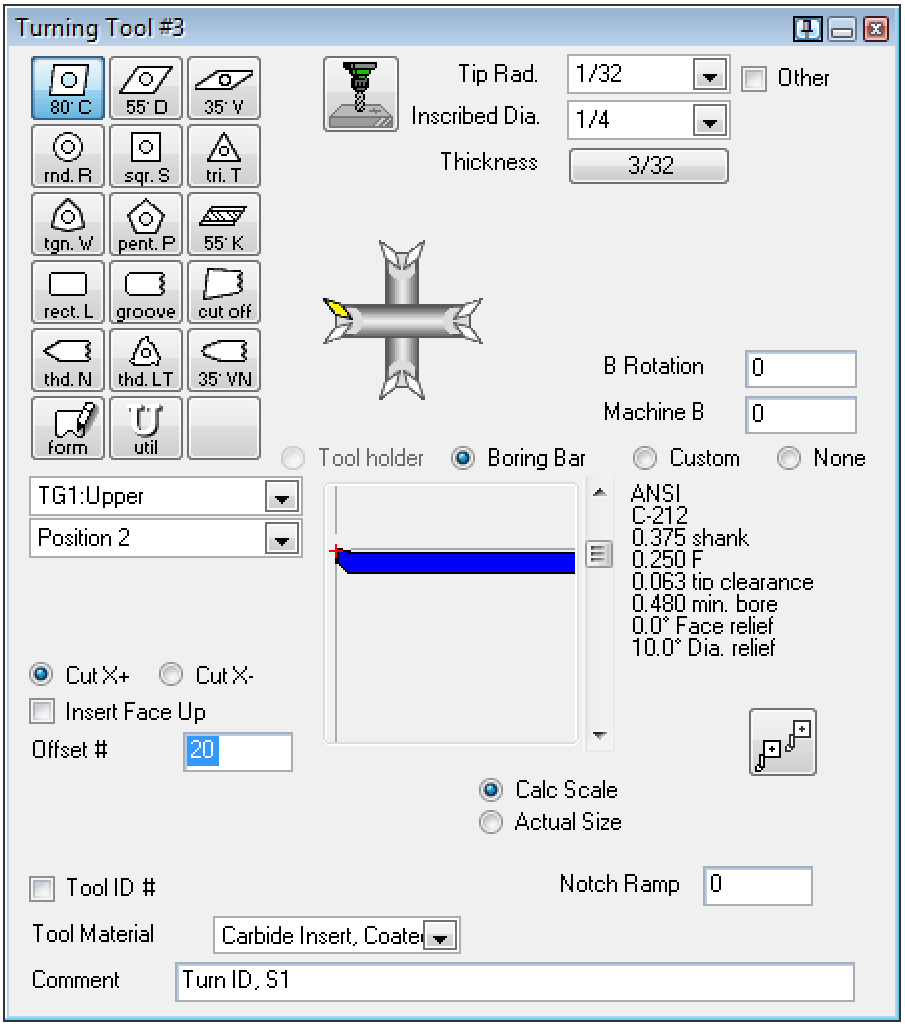
Lathe Tools - OD

To explain Lathe - OD, we use the tool in position #13 as an example. In order to get the tooltip in the correct location we need to apply a tool offset value. The system automatically aligns the tooltip to the front of the spindle and sets an offset so the touch off point is correct based on the tool thickness. This tool setup is fairly easy, we simply need to enter the tool holder length, which in this case is 4 inches. In the Tool offset data dialog we simply enter an Xr offset value of 4.



Lathe Tools - ID and Face

To explain Lathe - ID and Face, we use the tool in position #20 as an example. In order to get the tooltip in the correct location we need to apply a tool offset value. This tool setup is a little more complex as the tool holder shifts the insert in Z and the distance from the datum point to the center of the mount hole is 30mm or 1.181 inches. The holder is 3 inches long. so we enter a Z offset of `3` inches and an Xr offset value of `-1.181` in the Tool offset data dialog.



Tools Defined with Tool Holders

All tools will be defined with holders if the tool is going to be used in Machine Sim, so that the tool is displayed connected to the toolgroup.

Mini-Gangs and Extra Holders

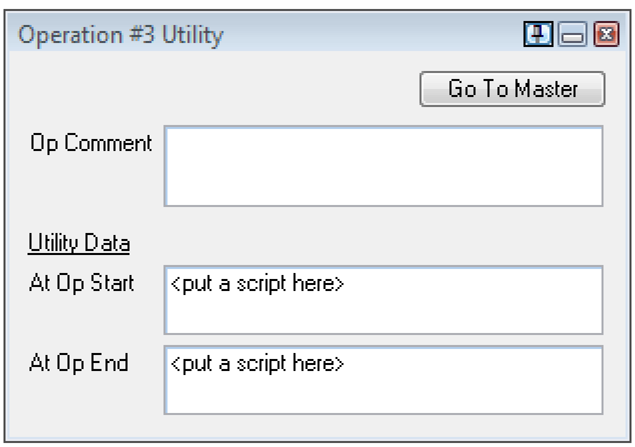
If a tool is ganged or if there is an extra holder block of some sort, you will need to apply a Tool offset data Shift so that Machine Sim is aware of the extra moves the toolgroup must take to get the tooltip to the correct position.

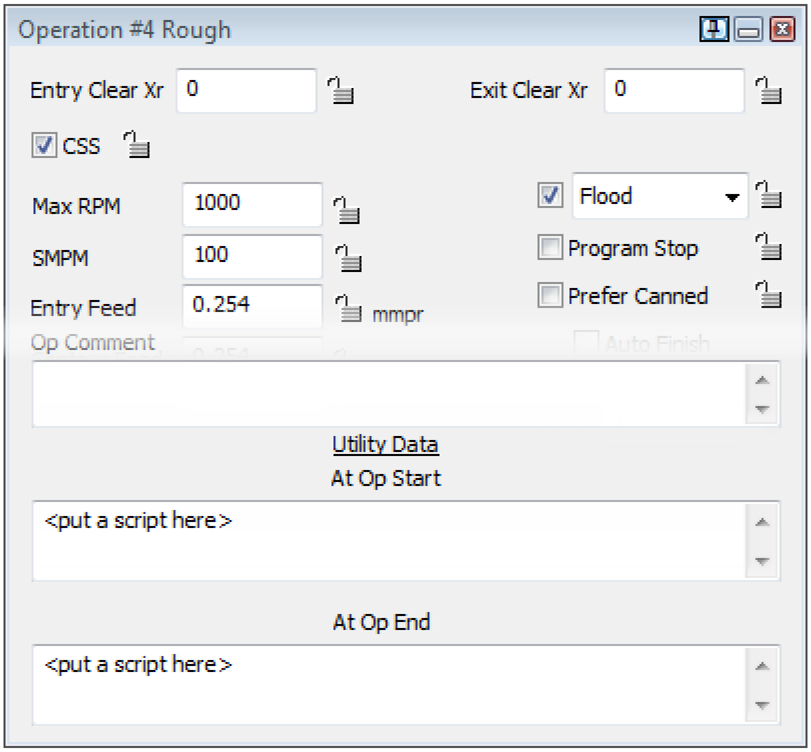
Scripting

Machine Sim Scripts

A simple but powerful scripting/macro capability is available in Machine Sim. This functionality allows you to create customized Machine Sim motion that simulate the motion of the real machine. These scripted macro programs (called "Scripts") provide a source for motion that is not known or managed by GibbsCAM at the detail level required to show a realistic simulation of utility operations for a given machine. In this way you can spend as much time as is necessary creating a very detailed and specific type of simulation for the utility operations of a given machine, e.g. to show the movement of tailstock and steady rests and to show the precise motion of the jaws on a chuck.

The Machine Sim Scripts are executed by Machine Sim whenever a utility operation is encountered during the replay of the operations in the VNC file. Machine Sim scripts can also be called directly via a command in the At Start Op or At End Op comments of the Utility Data of any operation (e.g. postscript). The script files should be placed in the machine model folder, in a sub folder called "`scripts`".





The Machine Sim Scripts are interpreted, meaning that the text file containing the script commands will be read and parsed sequentially (except for conditional commands) at the time of execution. Each script command will cause a Machine Sim action. The Machine Sim Script language supports local and global variables, simple math operations, and conditional logic commands. The scripting language is not case sensitive.

Types of Scripts

There are four different types of scripts:

Utility Op Start Script

This type of script is executed when a utility op of the same name as the script is encountered at the start of the first path feature of the utility op. This type of script is a "one-shot" script, where all other Machine Simulation motion is suspended, and the script is run serially. Start Scripts are stored in the sub-folder `/scripts/startscript`. A list of these scripts can be found in Machine Sim Scripts Utility Op Script Names

Utility Op End Script

This type of script is executed when a utility op of the same name as the script is encountered at the end of the last path feature of the utility op. This type of script is a "one-shot" script, where all other Machine Simulation motion is suspended, and the script is run serially. End Scripts are stored in the sub-folder `/scripts/endscript`. A list of these scripts can be found in Machine Sim Scripts Utility Op Script Names

Explicit Script

This type of script is executed when an explicit call to the script is made from postscript commands in any GibbsCAM operation, i.e. the At Op Start or At Op End utility data. These scripts are executed during op start if RunScript is in At Op Start, or at op end if RunScript is in At Op End (as covered in the PostScript Commands section). These scripts are stored in the sub-folder `/scripts`.

Implicit Script

This type of script is executed by default at particular key points in the machine simulation. Currently this includes a StartSim_script, Reset_script, (run when the rewind button is clicked), and Toolchange<N>_script, where N is the toolgroup number (e.g. "Toolchange3_script" will be run when TG3 encounters a toolchange). Additionally, there is an additional implicit script, Op Start, "StartOp_script", which is run at the start of every operation; if the op is a utility op, the utility op script is run AFTER StartOp. These scripts are run as one-shot scripts at the feature containing the runscript command. These scripts are stored in the sub-folder `/scripts`.

Machine Sim Scripts Utility Op Script Names

The Machine Sim Scripts that are executed as a result of utility data in the program (i.e. start scripts, end scripts and timebased scripts) use “base name” of the utility op with a suffix of `_script`. They are not case sensitive, but we recommend the use of capitalization as shown for readability. For utility operations with different subtypes, such as `LoadSpindleBarFeed_script` and `LoadSpindleRobot_script`, the main utility op type can be used for any subtype. If a subtype script is present, it will be used instead of the main utility op script.

If you have custom utility ops (i.e. utility ops that are not on the existing list, because they have been added by a custom VMM), the "base name" of the utility op can be found in Op Manager (it's the part of the Op Type following the last dot), or the user can contact the Post Department to get the details for their particular VMM's custom utility ops.

The current list of Utility operation script names follows.

LoadSpindle_script †	UnLoadSpindle_script †
LoadSpindleManual_script	UnLoadSpindleManual_script
LoadSpindleAutoBarFeed_script	UnLoadSpindleAutoChuck_script
LoadSpindleAutoChuck_script	UnLoadSpindlePartCatcher_script
LoadSpindleBarFeed_script	UnLoadSpindleGripper_script
LoadSpindleBarPull_script	UnLoadSpindleRobot_script
LoadSpindleSubSpinPull_script	UnLoadSpindlePartDrop_script
LoadSpindleRobot_script	UnLoadSpindlePushOut_script
TailstockIn_script †	SubSpindleOnPart_script †

TailstockOut_script † PosTailstock_script †	SubSpindleReturn_script †
PartShift_script † PartShiftManual_script PartShiftAutoChuck_script PartShiftBarFeed_script PartShiftAutoBarFeed_script PartShiftBarPull_script PartShiftSubSpinPull_script PartShiftRobot_script	SteadyRestIn_script † SteadyRestOut_script † PosSteadyRest_script † CatcherIn_script † CatcherOut_script † PartIndex_script † MoveTool_script † AllStop_script † MachMode_script †
† designates the Main Utility Op Type	

Commands

The scripting language includes the following script commands:

MoveTo

This command moves (animates) bodies along their axes to a position with a specified number of animation steps. This command can accept multiple bodes at the same time. The specified axes will move simultaneously.

```
MOVETO [Z102] [Z901] -50 STEP 10 DELAY 50
```

This will move the bodies "Z102" and "Z901" along their axes by -50 units in 10 steps with a 50 millisecond delay between steps.

GoTo

This command statically repositions ("pops") bodies to a new axes position.This command can accept multiple bodes at the same time. The specified axes will move simultaneously.

```
GOTO [Z102] [Z901] 0
```

This will move the body "Z102" and "Z901" to their "0" position.

SetPos

This command functions the same as GoTo but does not have redraw at the end.

Redraw

This command forces a redraw.

Delay

This delays a specified number of milliseconds.

```
DELAY 500
```

This will delay the system for half a second.

Load	Loads a part for the specified P body. Can do it invisibly if optional "Vis 0" is specified. `LOAD P1 VIS 0` Part 1 is loaded invisibly
Unload	Unloads the part that's standing in for the specified P body
SetVis	This command sets the visibility of one or more bodies. Use `0` for invisible, `1` for translucent and `2` for opaque. `SETVIS Z101 Y101 2` This will make the bodies "Z101" and "Y101" visible.
SetPartVis	Shows or hides a part
SetVar	This command defines a variable and sets its value. `SETVAR #INITDIST = 5.1` the variable #InitDist is defined and set equal to 5.1. The units are part units.
ChangeTool	This command changes a tool. It is typically used for machines with an ATC to more correctly render the tool change. Normally a tool change occurs just before an operation. If you are scripting an ATC's motion to the tool port and back to the part the system will, by default, only change to the new tool just before the new op starts. This command lets you force the new tool to be drawn at a more appropriate time.
Reparent	This command assigns the owner of a part to a P body so that it can be moved. It effectively "attaches" the part to a body (the parent body to the P body specified) so that if that body moves, the part moves with it, as in the case when a subspindle pulls the part out of the spindle. `REPARENT P1 P2` This assigns the ownership of the part in P1 to the P2 body and its parent.

Conditional Commands

The scripting language includes the following conditional logic commands.

```
IF

ELSE

ENDIF
```

Conditional expressions (the test in an IF statement) only support relational operators (`<,<=,>,>=,=,<>`), but the left and right sides may be complex arithmetic expressions.

Debugging Commands

Print <stuff>

This command writes the contents of <stuff> to the Machine Sim Statistics console (Machine Sim Settings -> Statistics... checkbox). Either a string literal or a script expression can be used as <stuff>.

```
PRINT "Z AXIS POSITION: "

PRINTLN %Z
```

Script Console output: Z axis position: -43.002149

```
PRINT "TAILSTOCK POSITION OFFSET FROM OP Z-POSITION TARGET: "

PRINTLN %Z901 - @ZPOSITION
```

Script Console output: Tailstock position offset from op z-position target: 26.0

PrintLn <stuff>

This command writes the contents of <stuff> to the Machine Sim Statistics console (Machine Sim Settings -> Statistics... checkbox). Either a string literal or a script expression can be used as <stuff>. PrintLn adds a line break after <stuff> where Print does not.

```
PRINTLN "THIS IS A TEST."
```

Script Console output: This is a test.

```
PRINTLN 100 * -100
```

Script Console output: -10000

```
PRINTLN "IN RESET SCRIPT"

PRINT "Z102 = " %Z102

PRINTLN "AND (Z102 + 10) * 2 – 150 = " (%Z102 + 10) * 2 – 150
```

Script console output:
In reset scriptZ102 = 0 and (Z102 + 10) * 2 – 150 = -130

About Commands and Redraws

The screen is not automatically redrawn after each scripting command. The behavior is as follows:

- GoTo and MoveTo do a redraw at the end of the command. MoveTo may do several redraws, one after each scene it automatically creates have been composed.
- SetPos, SetVis, Load, Unload, Reparent, ChangeTool, SetPartVis may change the graphic state of simulation, but a redraw is not automatically done at their completion. This allows a user to do multiple-command scene composition, and then show the results using Redraw when the scene is ready.
- GoTo, MoveTo and Delay may do an automatic redraw at the *beginning* of the command if the graphic state has been changed since the last redraw. This would be triggered by SetPos, SetVis, Load, Unload, Reparent, ChangeTool or SetPartVis.

Operators

The scripting language includes the following math operators:

+ (plus sign)
This performs an addition of the variables on both sides of the +.

- (minus sign)
This performs a subtraction of the variable on the right of the - from the variable on the left of the -.

*** (multiply sign)**
This performs a multiplication of the variables on both sides of the *.

/ (division sign)
This performs a division of the variable on the left of the / by the variable on the right of the /.

() (parentheses)
Parentheses are used for controlling the order of operations.

Variables

The scripting language allows for local, global, and operation defined variables. Local variables are defined by, used, and scoped internally to an MS Script. Global variables are defined either in a Script, or as part of a globally available environment that is created and managed dynamically by Machine Simulation. Operation defined variables represent utility operation data that is supplied by the user when a utility op is created (e.g. ZPosition)

- Local variables are formatted as:

  `#variablename`

- Global variables, which are read-only, are formatted as:

  `&variablename` (for example: `&MMToPartUnits`)

  The following is a list of the defined available global variables.

Variable	Data
&PartUnit	0=metric, 1=english
&OpType	0=mill, 1=lathe, any other value=none
&OpSubType	Mill: 0=drill, 1=Contour, 2=Pocket, 3=Thread Mill, 4=Surface, Any other value=none Lathe: 0=contour, 1=rough, 2=thread, 3=drill, 4=utility, any other value=none
&OpToolGroup	

Variable	Data
&ToolType	0=mill, 1=lathe, any other value=none
&LToolOffset	
&MMToPartUnits	
&P1OffsetZ	
&P2OffsetZ	

- Global variables can also be user-defined. These are formatted as:

  `$variablename` (for example: `$calcvar1`)

- Axis value variables, which are read-only, are formatted as:

  `%variablename` (for example, `%X102`, which will return the current position of the spindle2 X axis.) To set an axis value, use the SetPos command.

- Operation variables are formatted as:

  `@variablename` (for example: `@ZPosition`)

  The following is a list of the defined available operation variables.

Variable	Utility Op Data	Comment
@USERFLOW	"UserFlow"	
@USERWORKPIECE	"UserWorkPiece"	
@MOVESTOOL	"MovesTool"	This field's presence and contents tell us that this op moves the tool
@ATHOME	"AtHome"	This field's presence and contents tells us that this op is at home
@STARTOFFPART	"StartOffPart"	This field's presence and contents tells us that this tool starts “off part”
@ENDOFFPART	"EndOffPart"	This field's presence and contents tells us that this tool ends “off part”

Variable	Utility Op Data	Comment
@CSORIENTS	"CSOrients"	This field's presence and contents tells us that this Op's CS orients the part/tool
@ORIENTA	"OrientA"	If this field exists it contains A orientation
@ORIENTB	"OrientB"	If this field exists it contains B orientation
@ORIENTC	"OrientC"	If this field exists it contains C orientation
@TIME	"Time"	
@FEEDRATE	"FeedRate"	
@FEEDDIST	"FeedDistance"	
@ZCLEARANCE	"ZClearance"	
@XPOSITION	"XPosition"	
@ZGRIP	"ZGrip"	
@ZRETRACT	"ZRetract"	
@XDROP	"XDrop"	
@ZDROP	"ZDrop"	
@FROMWORKPIECE	"FromWorkPiece"	
@TOWORKPIECE	"ToWorkPiece"	
@ORIENTATION	"Orientation"	
@CSYNCHED	"CSynched"	
@WITHPART	"WithPart"	
@ZINITFACEPOS	"ZInitialFacePos"	
@ZPOSITION	"ZPosition"	
@AFTERSHIFT	"AfterShift"	

Variable	Utility Op Data	Comment
@OPENCOLLET	"OpenCollet"	
@SPINDLESPEED	"SpindleSpeed"	
@SPINDLEON	"SpindleOn"	
@FORWARD	"Forward"	
@SHIFTORIGIN	"ShiftOrigin"	
@PARTSHIFTDIST	"PartShiftDistance"	
@SUBINUNLOAD	"SubInUnload"	
@PARTINMAIN	"PartInMain"	
@PARTINSUB	"PartInSub"	
@MAINLOADED	"MainLoaded"	
@TOOLGROUP	"ToolGroup"	
@NEWPOS	"NewPos"	
@XNEW	"XNew"	
@XVALUE	"XValue"	
@ZNEW	"ZNew"	
@ZVALUE	"ZValue"	
@CSSPINDLEZX	"CSSpindleZX"	
@TOOLTIP	"ToolTip"	
@AUTOREMOVE	"AutoRemove"	
@TORQUESENSING	"TorqueSensing"	
@TORQUEVAL	"TorqueVal"	
@PULLBACK	"PullBack"	
@SPINUNLOADED	"SpinUnloaded"	
@FULLRETURN	"FullReturn"	

Variable	Utility Op Data	Comment
@POSTSX	"PosTSX"	
@POSTSZ	"PosTSZ"	
@MACHMODE	"MachineMode"	
@XCLEARANCE	"XClearance"	
@STEADYRESTNUM	"SteadyRestNum"	
@ZGRIP_ALT	"ZGripAlt"	A calculated value
@ZCLEARANCE_ALT	"ZClearanceAlt"	A calculated value
@PARTSHIFTDIST_ALT	"PartShiftDistAlt"	A calculated value
@LATHEMODE	"LatheMode"	Switch to Lathe mode
@RECREATEOP	"RecreateOp"	This will recreate the operation

PostScript Commands

Machine Sim Scripts allows for commands that are manually typed into the postscript (the At Start Op or At End Op utility data) or that are included in an Add G-Code utility operation. These commands include:

```
SETVAR(<VARIABLENAME>=<VALUE>)

RUNSCRIPT(<SCRIPTNAME>)
```

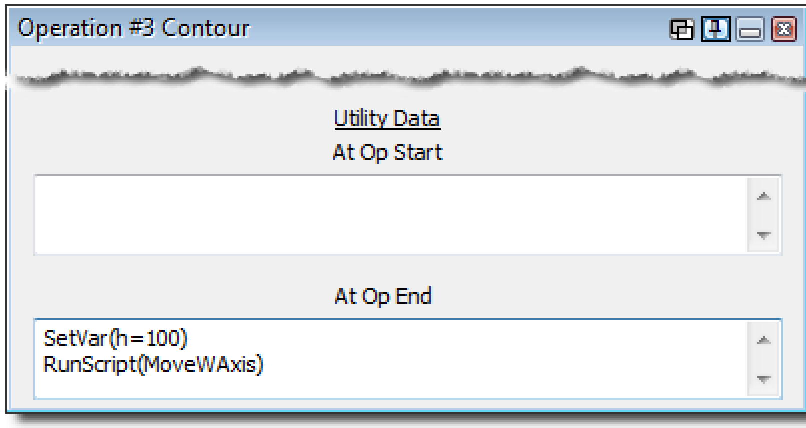
Please note that `SetVar` can only be used for global variables and the global variable prefix ‘$’ must not be used.

Example

A script named `MoveWAxis_script.txt` was created and you want to call it after Operation 3. This script requires a variable named `$h` to be set to `100`. Operation 3’s At Op End field is edited to include the following.

```
SETVAR(H=100)

RUNSCRIPT(MOVEWAXIS)
```



MDD Editor

MDDs

- The length of the mill tool is affected by the MDD setting called "Use Tool / Holder Length". When this option is checked the tool and holder (if available) are positioned so that the tool and holder stick out from the spindle at the spindle face. The tool shift offsets are applied from that default position. If the option is not checked then the tool tip center is shown at the spindle face, offset by the tool shift offsets.
- The axis limits defined in the MDD are used by Machine Builder and Machine Sim.

VMMs

VMM defined auxiliary axes

With customization, VMMs are now able to support the definition and positioning of axes, such as a subspindle, in the program based on standard behavior of utility operations. This allows for motion that does not result from machining operations to be handled by Machine Sim without the need for scripts for axes. The VMM defines axis motion for utility ops that relies on the presence of axes defined in the machine model. If the axes are present in the machine model, machine sim will move these axes whenever a utility operation that controls these axes is encountered. These newly defined axes will be tracked internally by GibbsCAM and controlled by Machine Sim. In this way, standard motion for utility ops can be programmed either generically or specifically by a VMM, and a resulting motion will occur in Machine Simulation, with or without the use of an accompanying Machine Sim Script. Additionally, the VMM can specify that a part is to be reparented in a utility operation. This allows for a smooth, synchronous transition of a part from one spindle to another without the use of special scripts.

Please note that VMM upgrades are required for Machine Sim to function correctly on multi-spindle machines, as scripts cannot handle subspindle moves.

ⓘ

You cannot change *template* VMMs, located in the read-only installation folder (default `C:\Program Files*\CAMBRIO\GibbsCAM\<version>`).

Custom VMMs are located by default in the global data folder (default `C:\ProgramData\CAMBRIO\GibbsCAM\<version>`).You can access this using Plug-Ins > Misc > Pathfinder > All Users VMM Folder.

Conventions

GibbsCAM documentation uses two special fonts to represent screen text and `keystrokes or mouse actions`. Other conventions in text and graphics are used to allow quick skimming, to suppress irrelevancy, or to indicate links.

Text

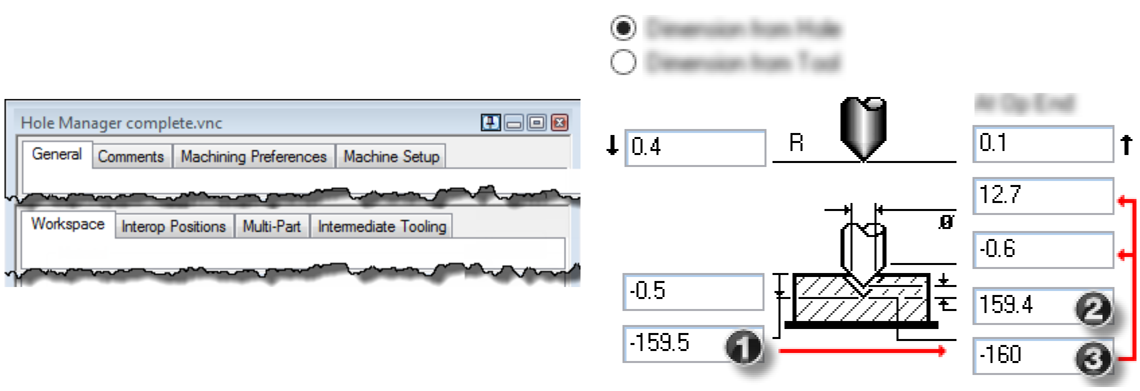
Screen text. Text with this appearance indicates text that appears in GibbsCAM or on your monitor. Typically this is a button or text for a dialog.

`Keystroke/Mouse`. Text with `this appearance` indicates a keystroke or mouse action, such as `Ctrl+C` or `right-click`.

`Code`. Text with `this appearance` indicates computer code, such as lines in a macro or a block of G-code.

Graphics

Some graphics are altered so as to de-emphasize irrelevant information. A “torn” edge signifies an intentional omission. Portions of a graphic might be blurred or dimmed to highlight the item being discussed. For example:



Annotations on a graphic are usually numbered callouts (as seen above), and sometimes include green circles, arrows, or tie-lines to focus attention on a particular portion of the graphic.

Faint green borders that outline areas within a graphic usually signify an image map. In online help or a PDF viewer, you can click a green-bordered area to follow the link.

Links to Online Resources

Link	URL	Action / Description
Go	http://www.GibbsCAM.com	Opens the main website for GibbsCAM.
Go	https://online.gibbscam.com	Opens a restricted website containing materials available for download. Requires a GibbsCAM Online Services account; to set up an account, contact GibbsCAM Support.
Go	https://store.GibbsCAM.com	Opens the website for the GibbsCAM Student Store.
Go	https://macros.gibbscam.com	Opens a wiki containing documentation and examples of GibbsCAM macros. Requires a GibbsCAM account.
Go	http://kb01.GibbsCAM.com	Opens a Knowledge Base article, **Contour Operations Using Thread Mill Tools**, that explains in detail the correct way to program Contour processes using Thread Mill tools.
Go	mailto:Support@gibbscam.com	Runs your email client to create a new message addressed to the CAMBRIO Technical Support department for GibbsCAM.
Go	mailto:Registration@gibbscam.com	Runs your email client to create a new message addressed to the CAMBRIO Registration department for GibbsCAM.
Go	mailto:Sales@gibbscam.com	Runs your email client to create a new message addressed to the CAMBRIO Sales department for GibbsCAM.
Go	http://www.autodesk.com/inventor	Opens an external website that provides more information on Autodesk Inventor products.
Go	http://www.celeritive.com	Opens an external website that provides more information on VoluMill Ultra High-Performance Toolpath (UHPT) from Celeritive Technologies.
Go	http://www.predator-software.com	Opens an external website that provides more information on a CNC editor and a virtual CNC viewer from Predator Software, Inc.

Index